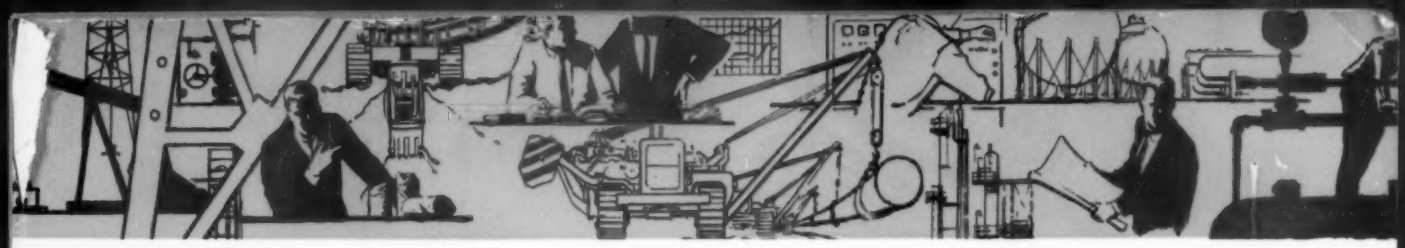
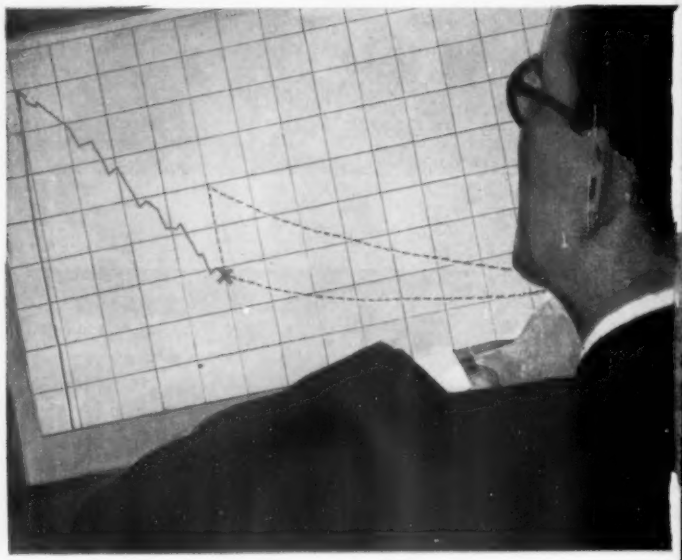


Petroleum Management

A PETROLEUM ENGINEER PUBLICATION NOVEMBER, 1961

What's Ahead for API?
The Thinker and the Doer
Helium Waste Called Serious
Slimholes Save in S. Louisiana
Forecast: 1962 Demand Up 3.2%
Stiffer Controls From Washington
Outlook on Pipeline Construction
How to Assess Joint Ventures
Ten Years of Desk & Derrick
The Bigger Egg



how Dowell planning helps make your frac jobs more profitable

Planning often makes the difference between the financial success and failure of a frac job. Here are four of the important planning steps Dowell engineers often recommend. When these steps are performed, there is no extra charge.

TESTING of formation samples and produced fluids with treating chemicals at Dowell laboratories helps avoid emulsion or plugging problems that might limit production increases. These tests are not always needed, but they are recommended whenever well conditions are encountered that vary from past studies, for example, in wildcat wells and edge wells.

SELECTING the most promising frac fluid and propping agent is aided by Dowell's fracture conductivity testers. Different treatment combinations can be compared and the most desirable one selected.

CALCULATING probable results for various sizes and types of treatments can be done by an electronic computer programmed with Dowell's engineering method—the Frac Guide*. Production increases and payout times are predicted, enabling the operator to select the optimum treatment for his purposes.

TIMING of a frac job is vital if an operator wants the maximum ultimate recovery with minimum total cost of production. Realizing the importance of timing, Dowell has placed new emphasis on the study of decline curves and formation energy records to help you decide **when** to fracture each well.

Ask about how these Dowell planning steps can be used to help you increase profits from your frac jobs. Dowell services and products are offered in North and South America, Europe, North Africa and Iran. Dowell, Tulsa 14, Oklahoma. *DOWELL SERVICE MARK

SERVICES FOR THE OIL & GAS INDUSTRY

DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

News

CURB CANADA IMPORTS?

Mounting volume of Canadian oil imports, which are not under quota restrictions, has caused Interior Secretary Udall considerable concern. He disclosed his Department is trying to reach an agreement with Canada to stabilize oil imports.

REDUCES CRUDE RUNS

Phillips Petroleum made a further reduction in crude runs according to K. S. Adams, chairman. This reduction for October follows previous reductions made in September, now 14,000 b/d under August runs. Through August of this year the industry processed more crude than during the same period of 1960. Vickers Refining reduced runs 3000 b/d, Phillips also recommended 3% cut in oil production.

CAPITAL HIGH

U.S. oil companies account for 45% of all American investments abroad, and a major portion of oil's overseas dollar this year is going into projects in North Africa, the American Petroleum Institute reported. In the U.S. the petroleum industry has the largest capital expenditure. Overseas, the oil industry accounted for $1.5 billion out of the estimated $3.2 billion American industries spent last year.

GAS INCREASE FORESEEN

Forecast by American Gas Association is that the industry will add 1,218,000 gas-heated homes during the 1961-62 season. This will bring total to 22,500,000 next spring, AGA reported at its convention in Dallas.

PLANT CONTRACT LET

South African Petroleum Refineries (BP-Shell) has awarded a contract to Foster Wheeler for a 70,000 b/d refinery at Reunion Rocks, Republic of South Africa. It is slated to go on stream by January 1, 1964. The new refinery will include these units: crude distillation; hydrodesulfurization; platforming (including stabilizer); sulfur recovery.

NEW RESERVES BIG

Oil reserves of Abu Dhabi (Trucial Coast, Middle East), where oil was discovered last year, are estimated at about 3500 million barrels by the chairman of Cie. Francaise des Petroles, one of the companies holding the concession.

JUDGE JOINS GULF

Royce H. Savage, Tulsa, Okla., a federal judge for 21 years, has resigned and joined Gulf Oil as general counsel. Early last year Judge Savage acquitted 29 oil companies including Gulf, of price fixing charges filed by the federal government. In his verdict Savage said the government's evidence didn't "rise above the level of suspicion."

News

W. GERMANY OIL USE UP

West Germany imported 18.9 million tons of oil products in first half of 1961, an increase of 29.4% over 1960. Crude oil imports soared to 15.05 million tons, up 46.1% over first half of 1960. Fuel oil imports were down 15.5% at 2.57 million tons. Increased imports reflect higher demand for oil products, replacement of coal by oil, and construction of additional refineries.

ENI SUPPLIES ISRAEL

Ing. Enrico Mattei, president of Ente Nazionale Idrocarburi, is said to have concluded an agreement by which ENI is to supply Israel 10,000 b/d fuel oil during the next year.

CRUDE OIL PRICE CUTS

Posted crude oil prices have been pushed downward through most producing areas. IPAA Executive Vice President Jameson noted "pressure of deteriorating product prices is forcing down an already inadequate crude price. TIPRO President West cited reductions as result of weakness in oil import control program...In Japan refining companies negotiated with Middle East producing companies for lower prices.

OPERATION MUDPIE

First you freeze the ground, then dig a 20-ft hole, 20 ft in diameter. You install an aluminum roof, vapor-tight sealed to the ground. Finally the cavity is filled with 850 bbl liquid natural gas at minus 258 F. This new ground storage was introduced at Lake Charles, La., by Conch Methane Services (London) and Constock-Pritchard (Kansas City). Conoco and Shell have interests in both.

PAN AM ENTERS ADEN

Pan American International signed 40-year concession agreement with Quaiti State of Shihr and Mukalla and Kathiri State of Seiyun, both in Eastern Protectorate, Aden. Agreement reportedly provides exploitation profits to be divided 45% to company, 55% to States.

SICILY HAS NEW PLANT

New 50,000 b/d refinery at Milazzo, Province of Sicily, owned by Mediterranea Raffineria Siciliana Petroli (Gulf Oil controlling interest) went on stream. Projected annual capacity of 120,000 b/d by end of next year gives promise refinery will become one of largest in Italy.

SIXTH WORLD CONGRESS

Eger V. Murphree, president of Esso Research and Engineering, will head the U.S. National Committee for the Sixth World Petroleum Congress in Frankfurt, Germany, in June 1963. Vice chairmen are Dr. Jerry McAfee, vice president, Gulf Oil, and Howard B. Nichols, senior vice president, Caltex. A brochure is obtainable from: Sixth World Petroleum Congress, Hamburg 1, Glockengreberwall 2-4, Germany.

News

SUPPLY FOR CENTURY

One item agreed on by national AIME leaders at the annual meeting in Dallas is that U.S. and Canadian petroleum reserves are sufficient for at least 100 years. R. R. McNaughton of Canada, president of AIME, and Lloyd E. Elkins, Tulsa, president-elect, said this would be true even if Middle East and South America sources were cut off. Elkins said U.S. can supply all its own needs for another 50 years.

RENEWS AEC CONTRACT

Atomic Energy Commission has extended for five years to February 28, 1966, its contract with Phillips Petroleum for operation of facilities at Idaho Falls, Idaho. Phillips will continue to operate materials testing reactor, chemical processing plant, engineering test reactor, special power excursion reactor test plants, and central plant facilities. Annual cost of the work is estimated at about $27,500,000.

SMOKER HEADS AGA

E. H. Smoker, president of United Gas Improvement Company, was elected president of American Gas Association at the annual meeting in Dallas. He succeeds Lester T. Potter, president of Lone Star Gas.

GAS IN HOLLAND

A Shell-Esso firm (NAM) found gas reserves in Groningen Province, Netherlands, which are estimated at 2 to 10 trillion cu ft. Drilling is halted until new concessions are negotiated and old ones restudied. At present all gas must be sold to State for distribution.

BOUGHT AND SOLD

Although Justice Department filed a motion in Federal Court to halt the sale of Honolulu Oil, stockholders approved the sale and transfer began. More favorable climate came from Internal Revenue Service which lifted its moratorium on issuing advance rulings on tax treatment of oil property sales. Assets are to be sold to Tidewater and Pan American ...Cities Service acquired interest in a subsidiary of Evence Coppee of Brussels. This gives Cities Service a position in the chemical and other fields in the European Common Market...Argo Oil is negotiating with Atlantic Refining for sale of its assets...Humble bought service stations in Florida from Singleton and Watson companies... Wichita River Oil Corporation acquired Blue Dolphin Oil in exchange for stock...Atlantic Refining acquired a majority interest in Buckley and Scott, fuel oil and burner sales... Air Products and Chemicals bought Sun's stock in Houdry, including Catalytic Construction.

PLAN BOLIVIAN LINE

An oil pipeline will be built from Caranda field to Santa Cruz, Bolivia, to connect with Arica pipeline to Pacific. Bolivian Gulf, discoverer of Caranda, plans the line. Estimated cost is $25,000,000.

Petroleum Management®

November, 1961—No. 12, Vol. 33

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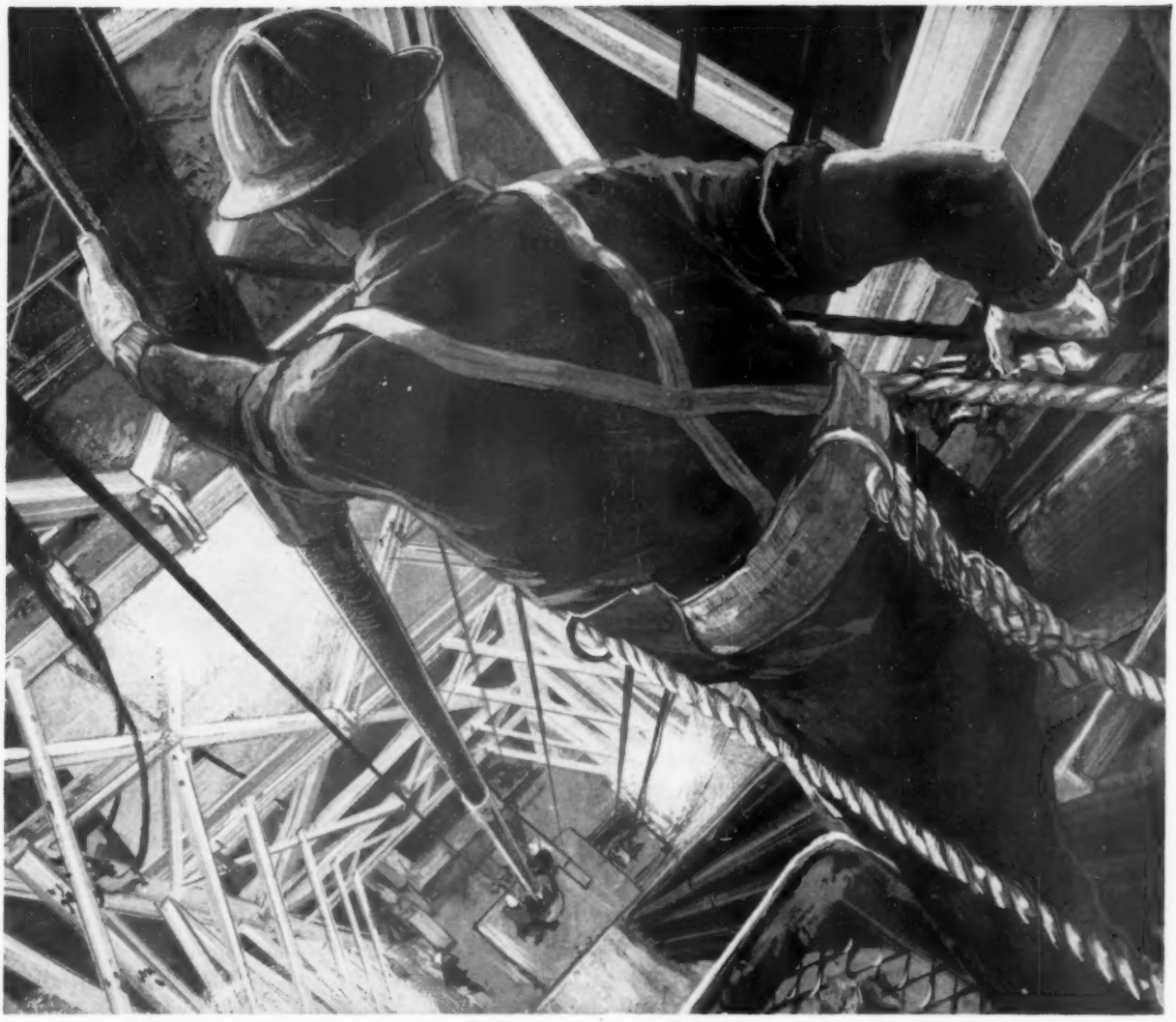

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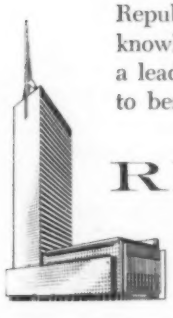
In the oil and gas industry, knowledge is acquired only through long years of experience. Republic, as a pioneer oil bank in the South . . . with the South's largest Oil and Gas Department, has this knowledge. For decades, Republic has been pacing the industry, keeping thoroughly informed on new trends and developments, credit ratings, equipment distributors and all the varied factors involved in oil and gas financing.

Republic offers you not only unlimited resources but also the strength which comes from specialized knowledge. Next time you need bank service on an oil or gas matter, talk to Republic, indisputably a leader in the field. We understand your problems . . . speak your language and have the resources to best protect your interests.



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OF DALLAS

"My Bank" to the Oil and Gas Man

CAPITAL AND SURPLUS $105,000,000 ★ LARGEST IN THE SOUTH ★ MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

Course of Oil

Let's Keep Unity Free

"I wonder how a system that has no unified responsibility can operate efficiently", said Joseph Swidler, new chairman of the Federal Power Commission, at the annual meeting of Independent Natural Gas Association.

When you come to think about it, you must agree it is remarkable. Our oil and gas industry is a complex of varied and diverse segments, independently owned and managed. There's no overall GOSPLAN like the Soviet state planning commission to say what shall be done and when and where. The initiative comes from individuals and companies. It hardly seems possible that these thousands of individual elements could mesh so efficiently to serve the U.S. consumer.

We asked the FPC chairman later what he would suggest to provide unified responsibility and he answered, "Maybe there's more to this system than meets the eye. It seems to work a lot better than I would have supposed."

There is "more to this system than meets the eye" and Mr. Swidler was perceptive to recognize it. There is a strong unifying force that is seldom recognized. Mr. Swidler was addressing one good example—INGAA. Here distributors, transmission companies and natural gas producers voluntarily unite to solve problems, to discuss plans, to advance new methods, to crystallize opinion.

Back when the young oil industry began buying equipment and found different suppliers used different measurements for such things as tubing threads, nobody went to a centralized government to lay down a set of standards. The task fell to American Petroleum Institute, where members worked together to fix practical standards. Because they are so soundly established today, API standards are followed internationally.

As techniques grew more complex, it was to these voluntary associations that industry people turned to exchange ideas, to learn new concepts of engineering, to tell of methods that had worked and of others that failed.

Groups formed to push one project—as Independent Petroleum Association of America was created to get a tariff on imported oil. IPAA now covers wider interests and is respected for diligent work for the independent producer.

A thoughtful man said recently, "We've never fully realized the benefits we gain through our voluntary organizations."

Can you imagine the oil and gas industry without them? Certainly there would have been no swift advance such as we have experienced without free associations to concentrate on practical aims and high purpose. Largest of these is API, which embraces the entire industry. Its members and staff study and report on problems in every division. We rarely stop to realize the value of its contributions to industry.

Our answer to Chairman Swidler is: We are a unified industry — not in a monolithic GOSPLAN, not under a trust or combine. We're unified by common interests in hundreds of voluntary associations where we pool ideas and have the privilege of agreeing or—perhaps more important—the right to disagree. Responsibility is not imposed but rests firmly in each individual and his company.

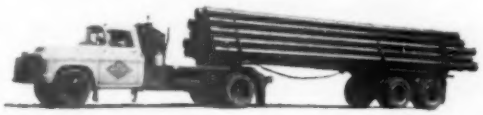
With free men isn't this the ideal as well as the practical course of unified responsibility?

— Ernestine Adams

Congrats and $25 for this quip to KENNETH R. TAYLOR, 313 Camellia Avenue, Orange, Texas.

The good word in pipe is Lone Star . . made in the nation's most modern steel plant. Lone Star quality is precisely controlled to rigid API specifications.

Fast overnight delivery to major mid-continent producing fields is routine . . delivery in mere hours is not unusual. You can depend on Lone Star line pipe, casing and tubing!



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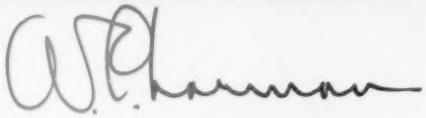
Profile



"He's a fine shot," said a business associate recently in describing W. C. Norman's game bird hunting, a rare diversion in his busy schedule.

The same phrase — "He's a fine shot" — fits perfectly the business career of this tireless 46-year-old former Texan who built Colorado Oil and Gas Corporation into an $80 million concern in seven years. Those close to the company's president are impressed by his determination to fix a target and then — in spite of Hades and high water — to hit the bullseye. The notches on his business rifle testify to his accuracy.

Born January 30, 1915, in Teague, Texas, Norman was trained in public accounting, and began his career in the oil business at Corpus Christi, Texas, in the pioneer days of natural gas cycling. In three years, he was involved in organizing some 14 companies, operating cycling plants, or active in oil producing, drilling, royalty. A major part of them were later merged into the Chicago Corporation (now Champlin Refining).

The broad knowledge Norman gained here proved invaluable when Gardiner Symonds, then president of newly formed Tennessee Gas Transmission, appointed Norman his assistant in 1943. His responsibilities grew steadily and in 1949 he was elected president of Northeastern Gas Transmission Company, which delivered the first natural gas to the New England states. Norman played a key part in a competitive race that saw Northeastern outdistance a high-powered rival for the New England prize market. That accomplishment at 36 was only the beginning of continuing successes.

Norman left Tennessee Gas and Northeastern in 1952 to become a partner in Lambert-&-Company, New York City, an investment firm with substantial oil interests.

The same year Colorado Interstate Gas Company formed Colorado Oil and Gas Corporation as a subsidiary to find gas reserves.

Norman was keen to develop a full-fledged oil and gas company so he agreed to head Colorado as an independent company, expanding its capital through the sale of common shares. In review, Norman commented: "Our assets after public distribution (of stock) consisted of undeveloped gas reserves in Kansas and Oklahoma, a cash account of $11,000,000 and an unlimited reservoir of ambition."

Along the road to building his company, Norman acquired two firms of note — Derby Oil Company of Wichita, Kansas, in 1954 and Jas. P. Marsh Corporation of Skokie, Illinois, in 1958. The Derby acquisition made Colorado an integrated oil company. The Marsh acquisition gave Colorado a stake in the rapidly growing instrument industry. Marsh is the oldest and one of the three largest manufacturers of pressure gauges.

This year — based on first-half experience — Colorado's gross revenues will exceed $51 million, compared to the $200,000 sales in 1954.

The fellow mostly responsible for this — W. C. Norman — still heads for higher goals.

Mr. and Mrs. Norman and their children make many trips together and share family recreations. The oldest son, W. C. Norman III, is a student at Denver University after a hitch in the Army, including overseas duty; one daughter, Mrs. Susan Simpson, is married and lives in Denver; the other two, Jill and Jimmy, are students in Denver public schools.

Although his company now operates in the Gulf Coast, the Rockies, Canada and Alaska, Norman has an eye on foreign opportunities.

"Our operations have not been confined to the North American continent as a matter of policy," he said recently, "but primarily because we so far have not found areas where we were satisfied with the political climate or which for other reasons were unsuitable to us. We shall continue to keep informed on foreign possibilities since it is obvious that with the increasing world demand and diminishing domestic supplies, petroleum reserves in politically favorable foreign countries will be a valuable asset in the future."

A 60-INCH VIEW OF CAT'S POWER SHIFT 583 PIPELAYERS

Report from Jack Hodges, General Supt., J. P. Neill & Company, Inc., Birmingham, Alabama

"The power shift on the new Cat 583 allows split-second shifts when juggling 60" pipe. The operator can handle the draw works levers and change travel speeds by nudging the *single* transmission lever with his forearm—impossible otherwise. When climbing these grades, he can smoothly drop to a lower gear to keep the load moving. Machines with other type transmissions must stop and slow down the operation."

Jack Hodges is talking about performance from the two 583s working on the industrial water line from Fort Smith Dam to Birmingham, Ala. They're handling 60" pipe, weighing 20,000 lb. per 40' joint, over rough terrain with grades up to 67½ degrees. "It's the kind of job that brings out the best and shows up the worst in any machine. That's why the 583s look so good."

The beautifully engineered combination of 235 HP, 137,000 LB. LIFT CAPACITY, POWER SHIFT TRANSMISSION, and an unmatched 21" GROUND CLEARANCE equip the 583 for heavy work in mountains or swamps . . . work that other machines can't handle over ground where other machines can't go. No wonder men who work with the 583 talk long and favorably about it.

For your own record-setting production *with low cost* . . . see your Caterpillar Dealer.

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

CATERPILLAR

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HEAVY-DUTY PIPELAYERS FOR THE HARD WORK

Conference Table

Helps Space Center

National Aeronautics and Space Administration's choice as a site for its proposed Manned Space Flight Center is a 1000-acre tract near Houston, Texas, according to Dr. Kenneth Pitzer, president of Rice University. He said the 1000 acres had been donated to Rice by Humble Oil & Refining Company with the understanding that it would be used for the NASA project.

Well Said

"I do not believe that Washington should do for the people what they can do for themselves through local and private effort. There is no magic attached to tax dollars that have been to Washington and back."

— President John F. Kennedy
in 1960 campaign speech.

The Service in Service Stations

The industry now has about 208,000 service stations. This means it operates about 416,000 rest rooms, half marked "him" and half "her." This is a rest room for every 430 Americans — and that's quite an investment. These free and fancy rest rooms provided by the oil industry represent both a marvelous and costly service. Just think what they mean to traveling folks. If it weren't for this unique oil industry service, there'd be a tourist behind every tree.

Up to now, we've utterly failed to carry this story to the tourists. In addition to the convenience involved, the travel-weary public is saved from all sorts of pain and anguish. We won't recite a lot of statistics, by way of example, the half-million "him" and "her" rooms provided by the oil industry at about every crossroads in round numbers: must prevent,

17 million cases of poison ivy.

14 million bee, hornet, wasp and yellow jacket stings.

91 thousand snake bites.

9 million infections from accidental contacts with briars, cactus needles, and barbed wire fences.

4½ million faintings or injuries from running as a result of contacts with bears, gila monsters, cougars, alligators, mean bulls, and other varmints.

$22 million in damages suffered to clothing during such escapes.

$9 million in fines for ignoring "no trespassing" signs.

$103 million in damages to automobiles parked hurriedly in illegal or dangerous zones along the highway.

Taken from "Losing Circulation," by Lloyd N. Unsell in the IPAA Monthly.

It's in the Bag!

The bag, with its thousand-and-one practical uses, is equally versatile as an "expression-maker" in our language. Our title, for example, owes its ring of familiarity to its closeness to the expression "It's in the bag," referring to a "sure thing." Literally, the saying means that the point in question is as secure as game in a game-bag.

No one likes to "be left holding the bag" because no one likes to be the sole loser while others profit. "Letting the cat out of the bag" is an embarrassing mistake, for when it's done, a secret has been inadvertently disclosed.

To "bag" any game, from rabbits to elephants, means to kill or capture the animal.

Good Wells Make Good News

A Report on Some Recent Interesting Acidizing Treatments

November, 1961

Dowell engineers have available the most complete line of acidizing materials in the industry. Here are four recent examples of how some of these materials were used to help operators improve their wells:

- **Lafourche Parish, South Louisiana** (Old Oil Well) Production had declined to 12 bopd on gas lift. Pay was the Miocene. Perforations were from 11,715 to 11,734 feet. Dowell acidized using Mud Acid emulsified with oil to retard acid reaction and to avoid contaminating formation with water. 4000 gallons of fluid was injected in eight stages of 500 gallons each. A two-barrel slug of gelled water diverting agent preceded each stage. *After treatment, well produced 187 bopd on gas lift.*

- **Madison County, Southeast Texas** (New Gas Well) Although drill stem test was negative, operator decided to run casing and perforate because cores looked good. Pay was the lower Glenrose lime at about 10,000 feet. Dowell injected 1000 gallons Super Mud Acid to clean up the immediate well bore area, then acidized the formation with 2000 gallons acid-oil-emulsion type Retarded Acid. 10,695 cubic feet of nitrogen was used to displace the acid. Then, 50 barrels of flush water were injected with 15,000 cubic feet of nitrogen. One hour after treatment, *well tested 1000 mcfd and 50 barrels distillate per day. Operator is pleased with results.*

- **Zavala County, South Texas** (Old Oil Well) Scale had choked production down to 1½ bopd pumping. Well produces from San Miguel sand through 2-inch tubing perforated from 4402 to 4412 with 8 shots per foot. Dowell used 1000 gallons regular acid with demulsifier to wash perforations. Acid was injected through a straddle packer lowered one foot at a time to assure opening of all perforations. After washing and soaking, packer was again lowered at one-foot intervals while acid was reverse circulated. Well was then shut in overnight. *Two weeks after treatment, well was pumping 23 bopd.*

- **British Columbia, Canada** (Old Gas Well) This well had been producing from the Nikanassin sand through two sets of perforations between 3757 and 3808. Production had declined from 4000 mcfd to 1800 mcfd. Dowell used Abrasijet® to cut circular notches in casing at 3761 and 3799 feet. Then, three barrels of Mud Acid were washed over notches at rate of one barrel every 10 minutes. An additional nine barrels of Mud Acid were squeezed into formation at 3 bpm. Pressure broke from 2350 to 1000 psi during squeeze. *After treatment, well tested 18,000 mcfd open flow—4½ times the original test when the well was new.*

Dowell engineers use acid, special materials and creative engineering every day to help operators improve net profits. Discuss your next acidizing job with a Dowell engineer. For service or more information, call Dowell. Dowell services and products are offered in North and South America, Europe, North Africa and Iran. Dowell, Tulsa 14, Oklahoma.

SERVICES FOR THE OIL & GAS INDUSTRY DOWELL
DIVISION OF THE DOW CHEMICAL COMPANY

"Sack" likewise has loaned itself to usage beyond its original meaning.

When an employee "gets the sack," he's been dismissed from his job. The expression comes from England where workmen once kept their tools in a sack. When they took a job, the tool sack was placed in the care of the boss, who returned it when the employment was over.

Not as old as "getting the sack" is the expression "getting into the sack" or "hitting the sack." G.I.'s in World War II used it to describe going to bed, probably an allusion to the sleeping bags they all knew.

In the South a bag is often called a "poke." It's always a good idea to avoid "buying a pig in a poke," for whoever acquires merchandise in that fashion, acquires it without checking its merits — or faults.

— From Aramco World, publication of Arabian American Oil Company, issued by Public Relations Department, T. O. Phillips, manager.

Even the Comics

In the "Our New Age" comic strip, the author and scientist, Athelstan Spilhaus, states, "Only a little over 100 years ago, the first oil well was drilled — yet in another century almost all our oil will be used up."

Sounds sad.

Lost: $190 Billion

You hear about inflation so much you get weary of it. American Institute of Economic Research, Great Barrington, Mass., has figured out how much depreciation has cost us since 1940. A good table to keep.

Year	*Total savings* (billions of $)*	*Relative buying power of dollar†*	*% Deprec. of dollar during Year*	*Loss of buying power (billions of $)*
1940	126.7	100.0	1.3	1.6
41	133.3	98.7	10.0	13.3
42	140.7	88.8	7.2	10.1
43	162.9	82.4	2.9	4.7
44	197.7	80.0	2.3	4.5
45	237.0	78.2	2.2	5.2
46	272.5	76.5	15.4	42.0
47	283.2	64.7	9.3	26.3
48	290.9	58.7	1.4	4.1
49	297.0	57.9	2.1+	6.2+
1950	306.3	59.1	7.3	22.4
51	313.3	54.8	4.0	12.5
52	328.5	52.6	0.8	2.6
53	346.8	52.2	1.1	3.8
54	366.7	51.6	1.0+	3.7+
55	383.4	52.1	.4	1.5
56	399.6	51.9	3.1	12.4
57	418.2	50.3	3.2	13.4
58	437.6	48.7	1.2	5.8
59	459.6	48.1	1.5	6.9
1960	479.4	47.4	1.5	7.2
			Total-	189.9

*Fixed-dollar-value assets held by or for individuals (life insurance policy reserves, Social Security reserves, savings deposits, bonds, mortgages, etc.). Data as of January each year.

†Data as of January each year, taking the January 1940 dollar as 100.0.

Small Business U. S. A.

A remarkable booklet based on the film "Small Business U. S. A. — The Story of Main Street" presents vignettes of failures and successes in business. It really should be "must" reading for the owners of retail outlets, service stations, machine shops and other small businesses. You'll probably be interested in the case histories.

If you are one of the enterprisers who has his own business, you'll be interested in the case histories. Single copies are available free from Dun & Bradstreet, Inc., Public Relations Division, P. O. Box 803, Church Street Station, New York 8, N. Y.

The Affairs of: _____

The Ohio Oil Company enclosed with its company magazine a booklet called "The Affairs of: _____." This statement was below: "Should I for any reason be unable to act for myself, here is a record of whom to see and where to look."

The booklet outlines all the information your family needs in times of emergency, tells about your will, whether you made one or not, the date, the lawyer, etc. It includes space for your property, your personal employment arrangements, bank accounts, securities, life insurance, disability, etc.

It would be a good idea to make a record of your own and give it to the person most concerned.

AMA Bookshelf

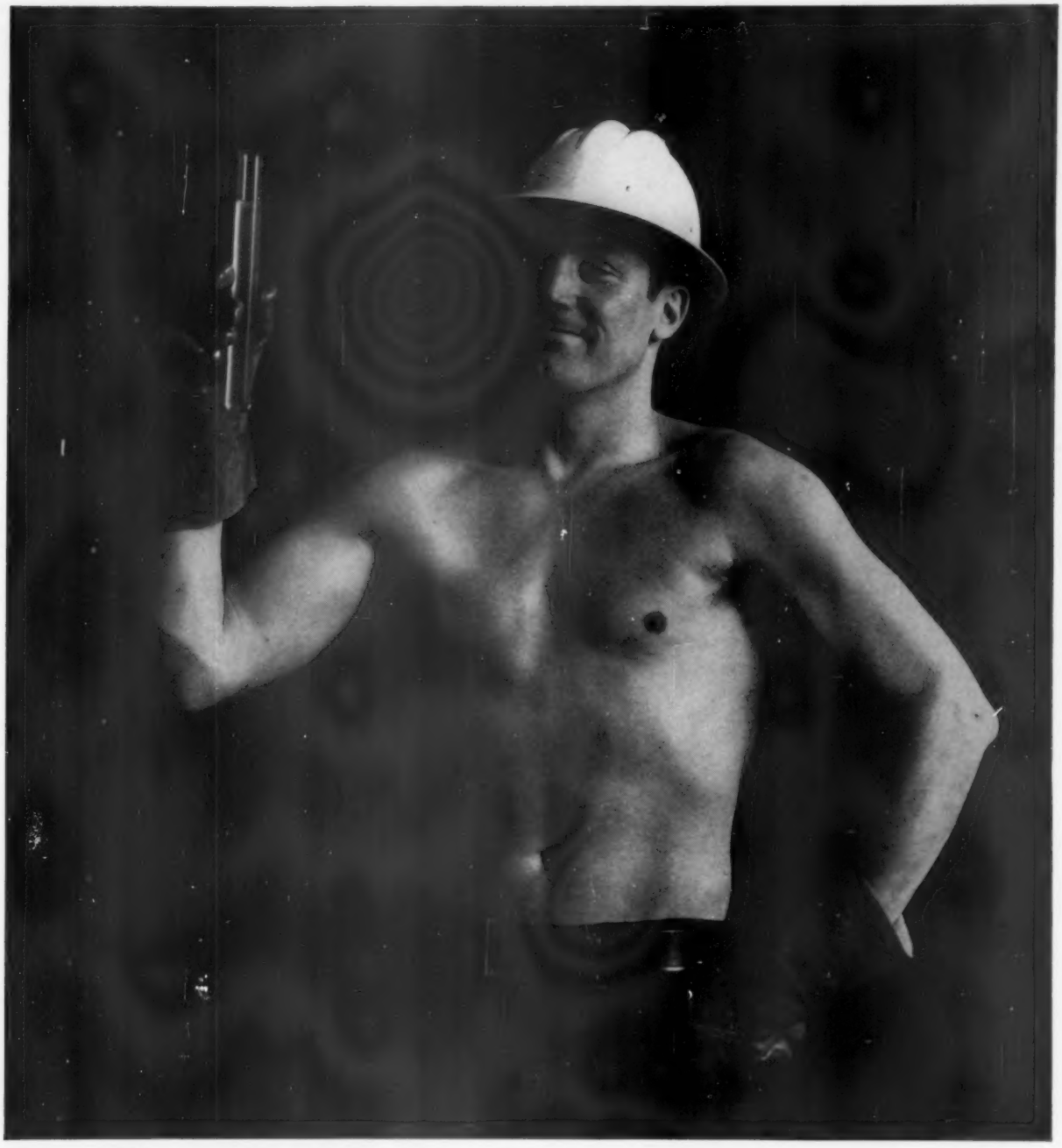
A new edition (1961-62) of AMA's Management Bookshelf has been distributed to its membership. It is also available on a complimentary basis to any interested executive writing on his business stationery. Readers may obtain copies from Publications Business Dept., American Management Association, 1515 Broadway, New York 36, N. Y.

Proved Again

It has been proved so many times you wonder who is left that needs proof of the force of a free economy. Here's another example:

Railroad	Assets (Billions)	Net Profit (Millions in 27 years)	Taxes	Dividends
Canadian Pacific (Privately owned)	$2.7	$758	$355	$392
Canadian National (Government owned)	$3.5	($470)*	none	$11

*Loss



The oilman doesn't know his own strength. Not all oilmen may realize it, but from petroleum come some of the strongest substances known to man—Epon® resins. These resins are so strong they can replace the rivets in airplane wings! And perhaps oilmen don't always realize their strength in another way—the many vital contributions they make to our everyday life. Thousands of products have been made possible by petroleum research. And what makes that possible? You, the oilman. So the next time you hear someone speak out against oil, remember you've good reason to speak up. After all, you're helping make petroleum one of the world's most versatile natural resources.

SHELL OIL COMPANY

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A MARSH Valve for every purpose

Ask for bulletins

These three bulletins, covering alloy steel, 416 stainless steel, and 316 stainless steel valves will be sent to you in a binder. Write.

Yes, three great series of needle throttling valves. Great in design and construction. Great in range of corrosion resistant service. Great in range of sizes and patterns.

All three series share the basic design and construction that has set new standards for Marsh Needle Valves.

All give smooth, close regulation and positive shut-off from a few pounds pressure up to high pressures.

All have body and stem guides machined from solid bar stock to provide extra strength and valve life.

All have precision ground stems and long fine-pitched accurately-machined stem threads for micrometer regulation and tight shut-off.

All have deep inlet and outlet threads for tight make-up.

All have special, long-lasting, readily-replaced, special "Marpak" packing incorporating all-but-indestructible Teflon in the stainless steel series.

You see a globe valve representing each series here. Note that the color of the handle identifies the series. Valves come to you individually sealed in strong, transparent plastic packages. In appearance, in operation, in service life you have in these valves the kind of product that only Marsh experience in *both* valve making *and* instrument making could produce.

Globe and angle valves in all three series are available with double female connections in sizes ⅛", ¼", ⅜", ½", ¾" and 1"—with male inlet and female outlet in sizes ¼" and ½". Panel mounted types in all sizes. Write for bulletins.

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Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta, Canada
Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas
Eastern Seaboard Warehouse: Marsh Instrument Co., 1209 Anderson Ave., Fort Lee, N.J.

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"Super Snoopers" are "Cost Detectives" who can help you ferret out wasted waste dollars. In reality they are Dempster-trained waste and refuse engineers who offer a free consultation and survey service to industrial plants (large or small) without obligation of any sort. These men are abreast of the latest breakthroughs in waste storage and collection and make hundreds of surveys and consultation calls each year, resulting in millions of dollars in savings. Sometimes a minor improvement, such as an inexpensive chute or conveyor, can mean thousands of dollars saved. Or, a few containers rented from a private hauler can effect big savings. There is a Dempster-trained engineer near you, and this consultation service is yours for the asking . . . so why not write today?

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Knoxville 17, Tenn.

☐ Please send details of consultation service

☐ Please send Catalog Brief 160

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"Bob, the computer analysis says we should buy those parts instead of making them"

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These are only a few of the problems that the Capital Investment Program handles. All it takes is the Program and an IBM computer that accepts FORTRAN programming language. The low cost IBM 1620 Data Processing System is one such computer.

The new Capital Investment Program is another of the many problem solving programs IBM offers you to help make your data processing system a more effective and more profitable tool for managing your business.

Your local IBM Representative can give you complete details on this, as well as previously announced programs, which included Sales Forecasting, Materials Planning, Inventory Management, Plant Scheduling, Work Dispatching, Operations Evaluation, Inventory Management Simulation, and many others.

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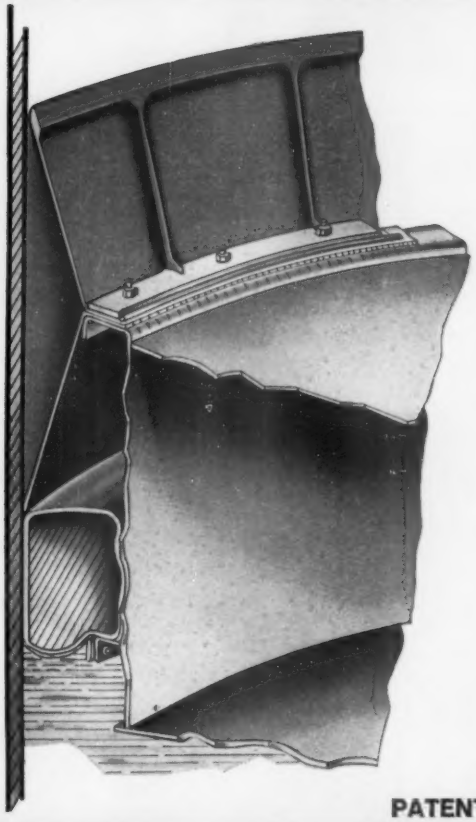
ALL FLOATING ROOF TANKS ARE FULLY EQUIPPED, **BUT...**

Only Tubeseal Has Lightning-Proof, Electro-Conductive Weather Shield



PATENTED

Tubeseal electro-conductive weather shields are an *exclusive tried and proved development.* They provide positive protection against lightning-caused rim fires. ■ How? By maintaining a *continuous* grounding bond between roof deck and shell—concentration of static charges is impossible. There has *never* been a lightning fire where any of the many hundreds of Tubeseal System Floating Roof Tanks are installed throughout the world—they're "lightning proof." ■ This is scientific and safe storage protection for the entire range of volatile products. Tubeseals can be installed on any of your tanks—new, old, riveted, or welded. You owe it to the future safety of your conservation facilities to investigate. Send for the Tubeseal Bulletin now—it could be important.

PDM

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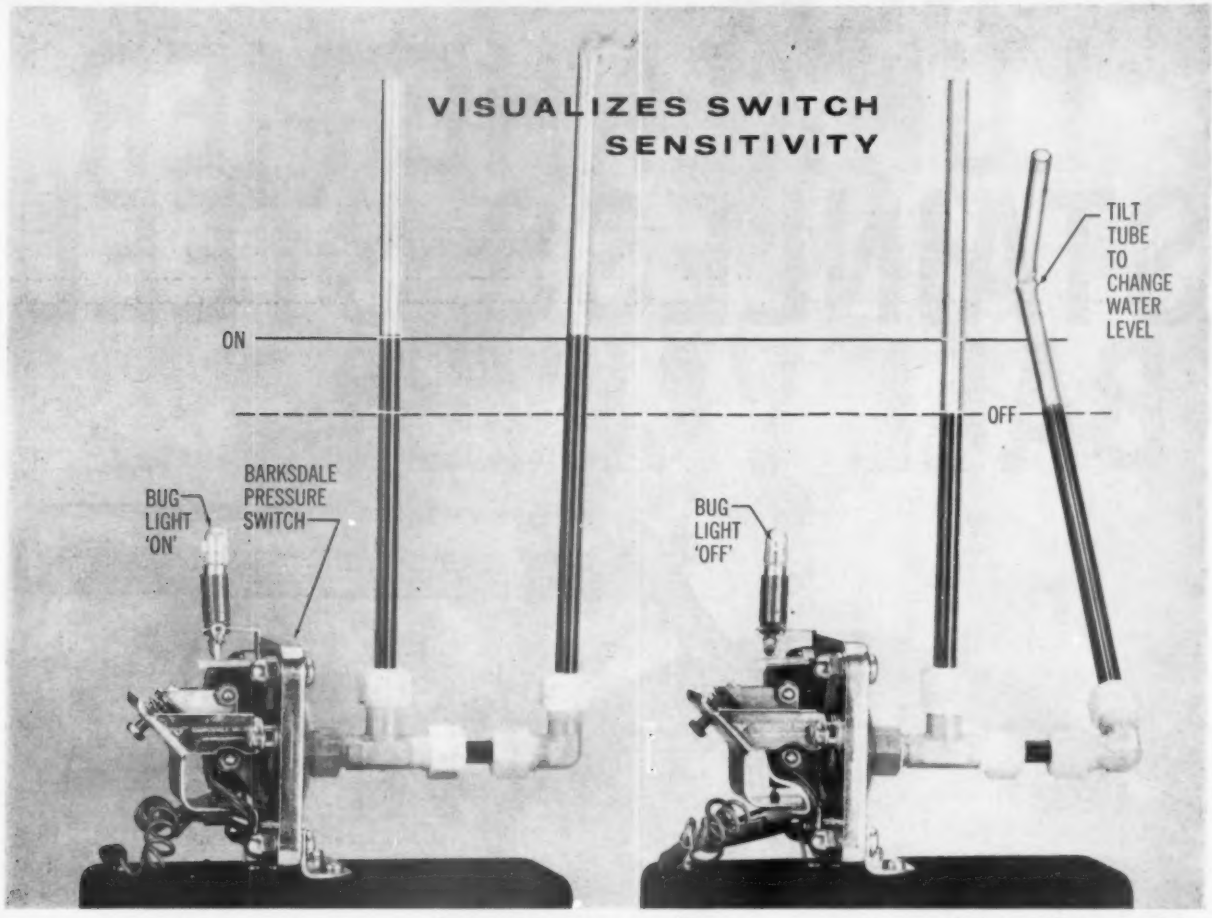
DO-IT-YOURSELF DEMONSTRATION



Pressure switch actuates and reactuates on less than 1" water; revises control accuracy standards

A demonstration kit like that pictured will be placed on your desk at your request so that you may see for yourself with what amazing accuracy one inch of water actuates and re-actuates new-design Barksdale pressure switches. Proof (test) pressure of switch pictured is 10 psi (about 23 feet of water) and maximum adjustable range is 3 psi (6 feet of water). The demonstrator works this way: Actuation and re-actuation points are identified on the vertical tube by metal rings. Fig. 1 shows a stripped switch in actuated position with bug light on. When tube is lowered (Fig. 2) the water level in the right hand tube drops. The bug light goes out when the switch reaches the re-actuation point. The accepted standard of accuracy in diaphragm pressure switches is ±1%. Barksdale switches are guaranteed for ±½% set and re-set accuracy. Standard models with adjustable ranges to 150 psi and test pressures to 300 psi are available.

Erector set design offers performance and cost advantages

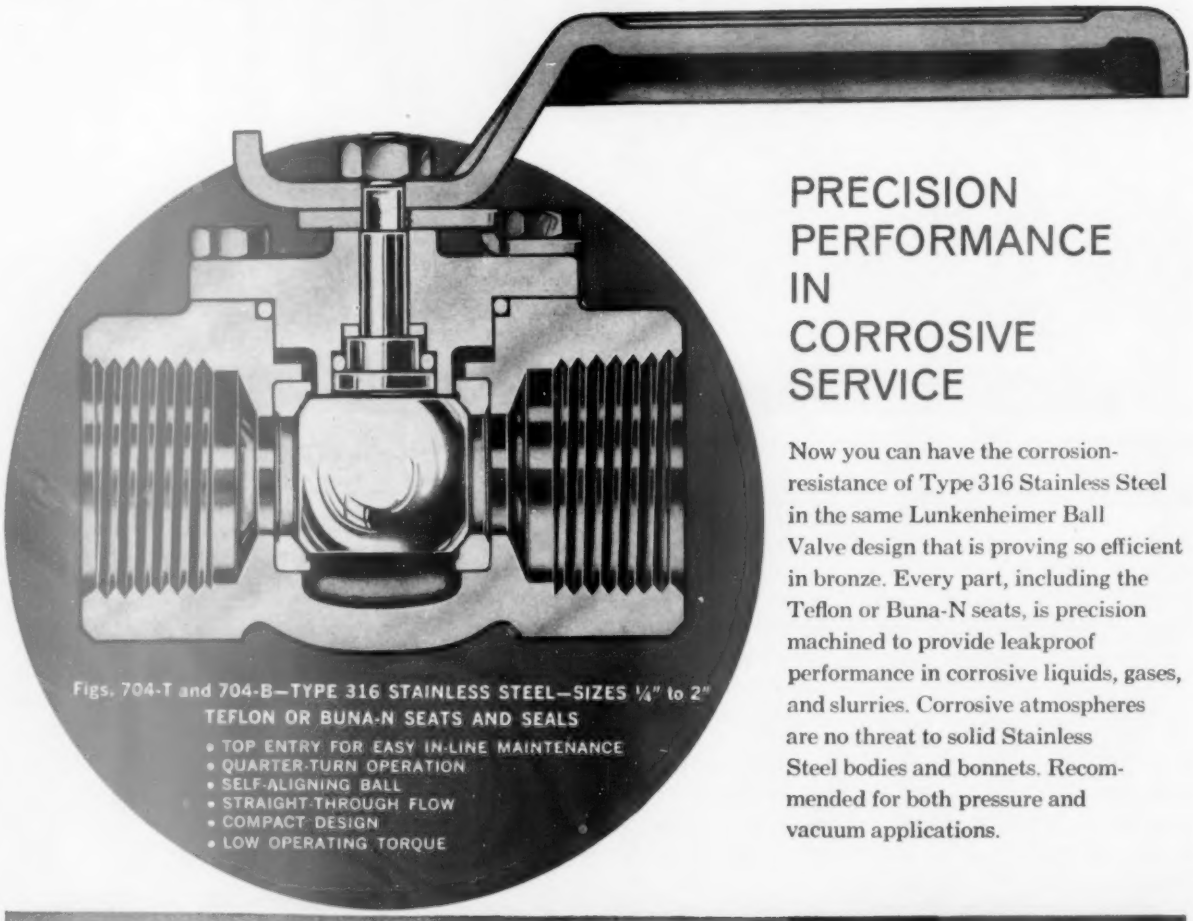
Barksdale pressure switches embody the specification improvements requested by representatives of varied industries who were consulted before designing was begun. Employment of the erector set construction principle allows wide choice in specifications that approximates a custom made switch and permits use of cost-cutting mass production methods that reduce prices as much as 25%. The following points are important: (1) Diaphragm capsules may be removed without disturbing switch wiring. (2) Because of erector set design, switches may be ordered to fit appropriate application. Addition of a switching element to the basic diaphragm unit makes a stripped switch for use in a common cabinet. Sealed housings (standard, terminal block, or explosion proof) may be specified as required. (3) Standard pressure connection is ¼" npt female pipe fitting; ½" fittings for mounting directly on ½" pipe are available. (4) Single setting or dual control switching elements. (5) Servicing instructions are on the inside of a tamper proof cover to allow for painting of unit. (6) Pottable electric outlets on explosion-proof housings; external adjustment may be made without breaking the circuit.

Demonstration on request

Ask for your do-it-yourself demonstration (of course, you will not be obligated in any way) and a copy of the new Barksdale pressure switch Handbook and Catalog 61-62.

Call your Barksdale representative or write to Barksdale Valves, 5125 Alcoa Avenue, Los Angeles 58, California.

NEW LUNKENHEIMER STAINLESS STEEL BALL VALVE



Figs. 704-T and 704-B—TYPE 316 STAINLESS STEEL—SIZES ¼" to 2"
TEFLON OR BUNA-N SEATS AND SEALS

- TOP ENTRY FOR EASY IN-LINE MAINTENANCE
- QUARTER-TURN OPERATION
- SELF-ALIGNING BALL
- STRAIGHT-THROUGH FLOW
- COMPACT DESIGN
- LOW OPERATING TORQUE

PRECISION PERFORMANCE IN CORROSIVE SERVICE

Now you can have the corrosion-resistance of Type 316 Stainless Steel in the same Lunkenheimer Ball Valve design that is proving so efficient in bronze. Every part, including the Teflon or Buna-N seats, is precision machined to provide leakproof performance in corrosive liquids, gases, and slurries. Corrosive atmospheres are no threat to solid Stainless Steel bodies and bonnets. Recommended for both pressure and vacuum applications.

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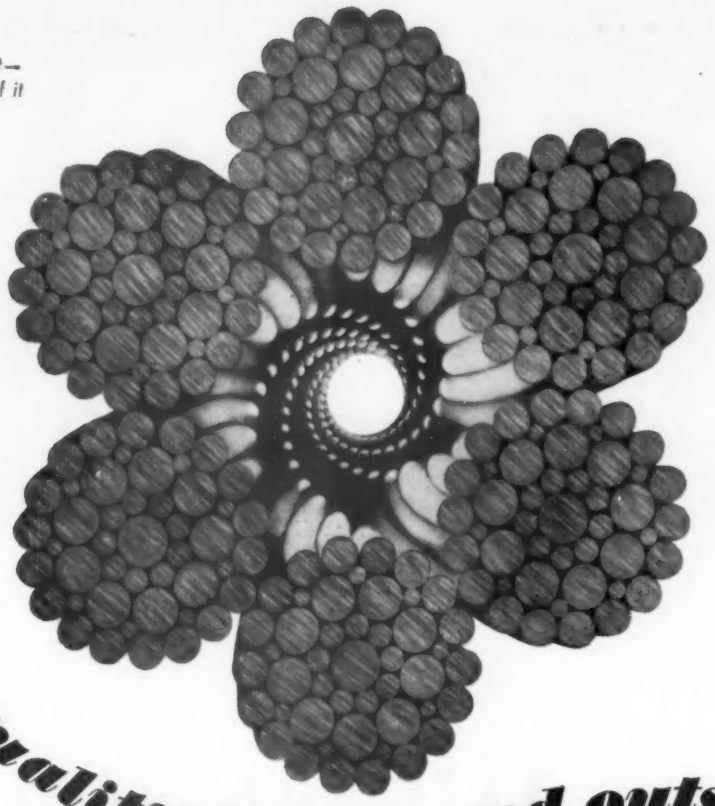
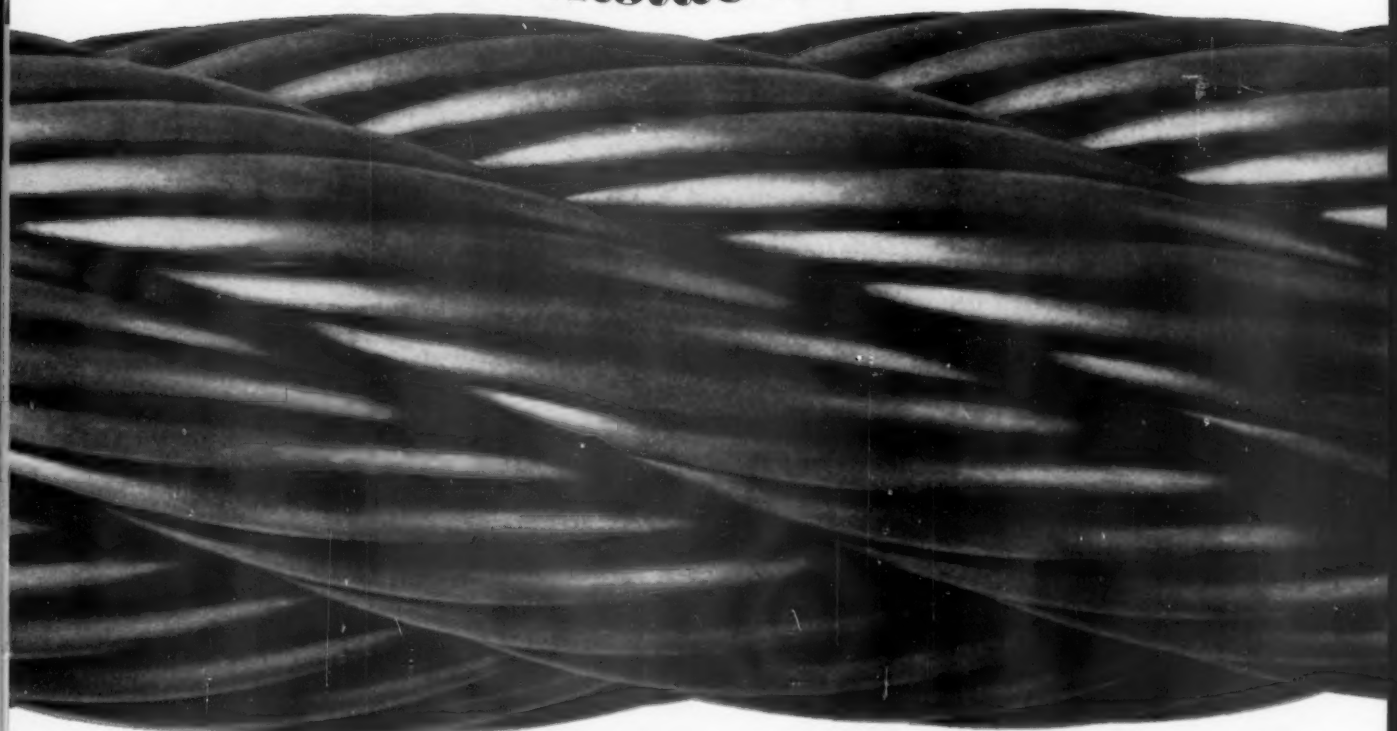
Get Circular 612 from your distributor or The Lunkenheimer Co., Cincinnati 14, Ohio.

L-561 24

We put a lot of work into it—
You get a lot of work out of it



Quality inside and outside



Two important angles on wire rope savings: the *quality* and *uniformity* Roebling builds all the way through Royal Blue Wire Rope. They give you a big, extra margin of service through every kind of wear and tear — and combine to make extra strong Roebling Royal Blue the toughest wire rope you can buy. Find out more from your wire rope distributor, or write for free booklet to Roebling's Wire Rope Division, Trenton 2, N. J.

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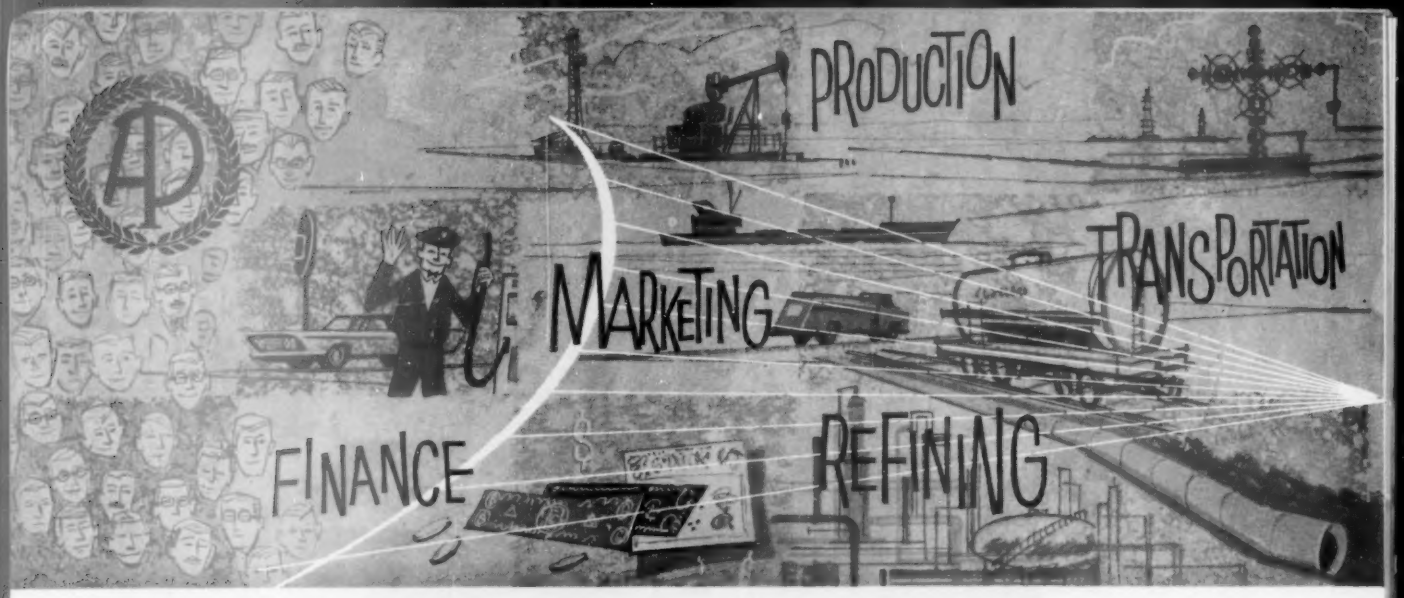


What's Ahead

"What, in your opinion, is the future of the American Petroleum Institute?"

We asked this question of more than 100 persons and collected material that was livelier and more penetrating than we expected. Because of its size and its blanket coverage of everyone in the petroleum and allied industries, it appears at first glance that API would be too massive and unwieldy to approach practical studies and too catholic to crystallize on any policy.

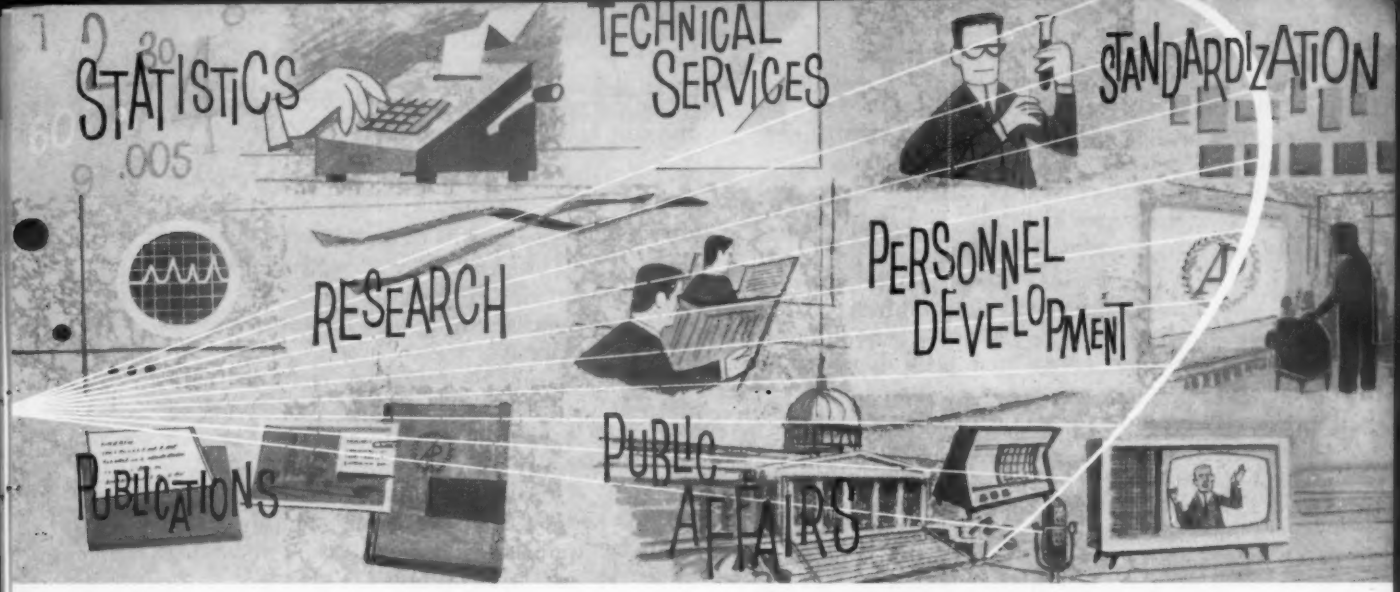
As one executive of an international company said, "The API is the only national organization in the oil industry and as such has built into it several major handicaps. For instance, it has been necessary for the API to adopt either a very broad policy or no policy at all with respect to matters of controversy within the industry. This is caused by the fact that as presently constituted the API is an umbrella for all those engaged in the oil business ranging from the international integrated majors to the smallest independent producer and marketer."

In spite of this the facts reveal remarkable aid to operations through API studies and enough unity on basic questions to mold plans for effective action.

Another executive stated, "Admittedly, issues arise where unanimity is difficult if not impossible of attainment; for example, imports. But there are a great many more issues where the API can speak for the industry."

An API director stated, "Principal functions of the API within the industry are to provide a forum for the discussion of oil problems and to develop operating standards. Its principal function outside the industry is to carry on such activities and programs which can be better and more efficiently performed by a trade association than by its individual members. I feel API has performed well in both areas."

Another commented, "There may be some who mistakenly view the API as primarily a lobbying organization. Yet this is but a fraction of its functions. Its contributions to industry statistics, standardization of technology, encouragement of engineering and scientific progress through sponsorship of committees and meetings, all have made invaluable contribu-



for the API?

by Ernestine Adams

tions to the welfare of the industry. All of these activities, moreover, are dynamic in their nature. They must be continued in the years to come even more vigorously than in the past."

This paragraph from an astute company board chairman sums up the opinions of several observers: "I feel confident that the API can continue to lay down basic principles to guide the petroleum industry in future years as it has in the past. There is no organization that can take the place of the API in meeting the challenges that constantly arise in a great and fast moving industry such as ours."

First, let's stop here and take a look at the American Petroleum Institute. As one executive, who has served API in several offices, said, "In a general way I knew what the functions of the API and its various divisions were. But when it got down to specifics, I soon found out how little I really knew.

"I also discovered I had a lot of company. Outside of API committee members and API staff itself, I found few oil men who could give me a rundown on its activities."

Our industry has a thousand associations but API was the first and is the only organization representative of the industry as a whole. After World War I — in 1919 — former members of the National Petroleum War Service Committee set up the American Petroleum Institute. The charter reads that the objects of the Institute are, in all lawful ways:

1. To afford a means of cooperation with the government in all matters of national concern
2. To foster foreign and domestic trade in American petroleum products
3. To promote in general the interests of the petroleum industry in all its branches
4. To promote the mutual improvement of its members and the study of the arts and sciences connected with the petroleum industry.

In the 42 years since the Institute charter was written these objectives have remained steadfast. As a marketer in our survey said, "This is an ever-changing business, and API manages to keep an alert finger on its pulse."

Members are companies and individuals. In recent years membership has run above 10,000.

Individuals pay $10 a year and companies pay varying amounts. The organization, with headquarters in New York, is managed by a board of directors and an executive committee, a full time president and his staff. The board chairman is from industry.

Five Operating Divisions

From the first there have been divisions by specialized work, which now include:

1. Finance and Accounting. Concerned with policies at corporate level and four branches of industry. Study insurance, budgeting, auditing, personnel development, systems, banking and finance, etc.
2. Marketing. Sixteen committees working to improve distribution, handling and use of petroleum products. Latest work force is the Travel Development Committee organized to encourage more motoring as recreation. Others include: Lubrication, operations and engineering, research, etc.

A top marketing man explained what this division has done on standardization: "Work has been started to improve the interchangeability of marketing equipment. This should save money for all oil marketers. For example, with the help of the gasoline pump people the location of the bolt holes and suction stubs in gasoline pump bases has been standardized. Now the changing of pumps will be a simple matter compared with the past."

3. Production. This division has headquarters in Dallas, Texas. It develops standards for oil field equipment and studies drilling and production practices. Divided into chapters under five districts.

Of the production division, an independent operator who belongs to many specialized organizations, said, "I can remember when if you made an oil well connection you had to see it completed with pipe from one company because threads were different."

Another producer declared, "For actual production problems, API is the best. It has been a big help to our operations."

4. Refining. Has 11 working committees to study refining technology.

One executive said, "The Refining Division has certainly made a splendid record for itself in the exchange of ideas among refiners to improve their operations."

5. Transportation. Five working committees on highways, pipelines, railroads, water freight, communication facilities.

"The Transportation Division has been effective in its work," according to one oil man, "and has protected the industry from many unfair Federal regulations that have been proposed." Having headquarters in Washington helps this division get things done more quickly.

Service Departments

Service departments cover all branches and serve public interests as well as industry.

1. Department of Statistics
   Collects and distributes industry-wide statistical data.
2. Department of Technical Services
   (1) Provides staff support for committees on medical and health, research, safety and standardization.
   (2) Concerned with LPG, evaporation, corrosion, composition and properties of petroleum, weather forecasting, and other items.
   (3) Acts as liaison between API and other organizations.
3. Committee on Public Affairs
   Handles public relations, education, employee information, opinion research, taxation.

Several commented on this Committee, which was formed in 1958 to take on the functions of American Petroleum Industries Committee and Oil Information Committee.* Local efforts on legislation and education were left to state organizations.

"The merging of the former APIC and OIC into the present Committee on Public Affairs has provided every segment of the industry with a more powerful and effective voice in government and public relations," declared one member. "Certainly the industry is for the first time meeting head-on the criticisms of profits, prices, taxes, bigness, etc. Not only are these questions being answered on the outside, but the program on employee information is helping to indoctrinate our own people with the true facts underlying these matters."

An oil executive, whose judgment is highly respected, made this statement: "The public relations effort of the Committee on Public Affairs is hampered by unwise price wars, which are difficult to explain, but by continually pointing out the bad impression they give the public I think the Committee does a needed job. The school program, employees information program, and other efforts seem to me to be intelligently directed."

Speaking of legislation, another board chairman said, "The API can and is helping on governmental relations matters where there is unanimity of opinion among the membership. For example, the API has vigorously and effectively represented the industry with respect to the national fuels policy controversy, and is

*See "Let's Take a Look at API Public Affairs," Engineer magazines, November 1958.

responsible for development of the industry's policy on conservation of wildlife and natural resources."

Along this line, API membership can also reach agreement on taxes. For instance, last year a program was carried out to hold federal taxes on gasoline to 3¢ a gallon. Back in 1931, API took part in stamping out gasoline tax evasion, which was widespread at that time. This unusual position — where an industry association aided in enforcing tax laws — demonstrates the Institute's usually sound approach to government matters. Even then API was working toward excise tax reduction, but it also wanted tax laws equitably enforced.

API directors and staff, and specially the Committee on Public Affairs, lean over backward from any act that could even distantly be connected with pricing, margins, commissions, or anything resembling competitive matters. Right now, when oil prices have eroded as the price of almost everything else increases, the subject of prices is extra untouchable.

Some of this super-caution was the result of the strange anti-trust case that never came to trial. Filed in 1940 by Assistant Attorney General Thurman Arnold, the Institute and 367 companies were charged with supervision of policies designed to restrict production, eliminate competition, and enable defendants to dominate petroleum industry. Because it covered virtually the entire industry, it became known as the "Mother Hubbard" case. Nearly 11 years later, in 1951, the suit was dismissed. No steps were taken to bring the case to trial. It is a sad fact that political ends are often served by taking a whip (even a frail one) to the petroleum industry.

This enforced extreme caution is sometimes frustrating. One director views the limitations philosophically: "The API is not faultless; and at times it would appear does not, in an assertive way, assume the leadership that it could. In saying this, however, I am cognizant of the fact that the over-all comprehensiveness and the complexities of the problems that are brought before it make it easier to understand. After all, we are members of a highly competitive industry; and the API directors are made up of individuals whose viewpoints cannot always be the same. They differ because of the competitiveness involved. I believe it Utopian to ever hope for a one-big-happy-family atmosphere. This is not reasonable to expect, and perhaps would be unhealthy if it existed."

Research activities are sponsored by the Institute and by each of its divisions. Overall projects are fundamental. Division projects are more specific. The Fuel Oil Committee, under Marketing, is conducting a program to improve oil-burning equipment. Information will be given to manufacturers as an aid to produce cheaper, more efficient oil furnaces and heaters.

"This Division, by itself, is worth all the effort put into API," said the president of a large domestic company. Another oil man commented enthusiastically, "Every company appreciates the work done in research."

Do they?

Like other API departments and projects, few outside the staff and committeemen directly realize the extent of the work accomplished.

Research is not actually done by API. Projects sponsored are assigned to educational institutions. They are usually fundamental and results are made public.

And the Future?

Several executive committeemen mentioned the meeting in September as a very satisfactory one. One said he was heartened by good reports and felt that Divisions had been streamlined so they would be more effective in the future.

Stimulating new plans and new ideas were under discussion. One of the departures, which has doubtless had intensive consideration, is the association of Congressman Frank Ikard with API, announced October 9 by Frank M. Porter, API president. Ikard's legislative experience can be useful in interpreting the petroleum industry to Washington and, perhaps also, Washington to the industry.

Said a member of the executive committee, "Government's ever increasing regulatory agencies present problems difficult to cope with. We must make a strong attempt to clarify the issues and improve our approach to the task."

Another pointed out, "We can go to Congress and tell our story and get a fair and square hearing. Congress has always given us a fair shake and we should remember that."

There was hesitancy on the part of some to state an opinion. One reason given was that men who directed the API should not evaluate it. From our side they appear to be most able to appraise the work. Another objection was that new plans were under consideration. From our observation, this is, or should be, chronic. One API director noted, "The API is doing a good job which is continually under appraisal by its directors and members."

That API has had excellent leadership at top levels is unquestioned. One executive remarked on this: "Since its organization, the American Petroleum Institute has had the guidance of the best minds and talents in the industry. For that reason, it has experienced a phenomenal growth as it has likewise gained universal respect. So long as it commands this respect, it will con-

tinue its unchallenged position of leadership in the petroleum industry."

One director was more specific, "I also believe that beyond any doubt Mr. Frank M. Porter, as president, has brought progress, integrity, and efficiency to the Institute. Under his leadership, much progress has been made; and as a result of this, in the national Congress I believe the API today has better acceptance than perhaps it has ever had in the history of the industry."

Not always is dedicated officer material available at local chapters. Said an independent operator, "I've never taken part on the national level but I've belonged to the local API chapter for years. Here it depends on the leadership. Some officers get in and we have parties; another leadership gets in and we have constructive programs. On balance I'd say our chapter does more good so far as actual operations are concerned than any other association I belong to and I belong to several. I'd bank on it for future operation problem-solving, too."

This comment refutes to some extent what one large company executive felt should be the future direction of API. He said, "Since the independent segments of the industry have very strong regional trade associations, it would seem that the role of the API in the future would become more that of a national and international organization. I feel that the big role for API to play will be in the field of international government and public relations. The U. S. controls either directly or indirectly at home and abroad by far the largest portion of the world's oil production, and therefore it is only natural that a trade association seeking to represent the oil interests of this country should become more active on the world scene."

The chairman of one large company stated, "Generally, I think that the API has a bright future. We have many problems but they all rest on three basic things — namely, the gas situation, the import situation, and the flags of convenience. The other problems all seem to be effects rather than cause. My hope is that the industry can arrive at a solution of these problems and their effect on the industry."

Another committeeman commented, "I feel API is a significant force in our industry. It provides a meeting place for the various segments and I believe is becoming more effective. Certainly it is better supported than it ever was."

"As to the future of API," said one who has served the Institute well, "It will be interesting to see what effects the proposed addition of a Washington executive will make. Hopefully, this will provide the API with more effective channels of communication in Washington. As to its role in the international field, this is still in development, but I think offers great promise in terms of services to the U. S. member companies as well as to the important producing and consuming areas of the world."

One job API could stress was suggested by a member. He said, "Here's an organization that could do a needed job in emphasing communication between management and field. In this period of financial scrutiny, accountants and lawyers are going into top management without experience in operations. API is the one organization that can provide reciprocal education between branches and high levels of management."

One director commented, "I expect that the API will improve and increase its services to the industry in the normal course of events. In brief, I believe the future of the API is as sound as the future of the industry itself. The nature and quality of its services to the industry in the years to come will largely be a reflection of the support and direction which it receives from the membership."

A plain member made this observation, "Periodically the API starts to take itself awfully seriously and the people wonder if they should do this or could do more than they are doing to be better spokesmen for the industry. They get frustrated when they realize the limitations of an organization as comprehensive as API is. Maybe they'd feel better if they were more appreciated. They do so much that they get little or no credit for. I wish the industry itself understood better what the API does."

Our comment on that is: The API is more approved and appreciated among the rank and file of the industry than casual observation reveals. Even the critical member wants it very much as it is, with his idea incorporated.

Since we agreed that no one would be quoted directly and most interviews were taken orally, discussions and opinions were frank and informal. In our view, results of the survey showed petroleum people have a definite pride in American Petroleum Institute and a pretty good understanding of its achievements and limitations. This evaluation from a marketer sums it up:

"No large industry can always present a united front, but mutual understanding of its various segments is being developed with conspicuous success in some important areas.

"Government relations present problems, many of which cannot be solved immediately, though they may be simplified, and the intent is in that direction.

"In my opinion the stature of API continues to advance, with greater and more enthusiastic participation by oil men in all of its divisions." ■

Managerial Paradox: The Thinker and the Doer

by Leon C. Megginson

A manager is a paradox, because he is only one person but he must be all things to all people. First, he is asked to be a thinker and a scholar. Concurrently, he is supposed to be an organizer, a promoter and a "good will" man. He is also called upon to be a "Good Humor" man with his employees. He is supposed never to commit the unpardonable sin of disciplining or alienating the affection of his employees, and yet there is pressure to "chop heads" when conditions dictate.

With this schizophrenic personality forced on him, there is little wonder that executive neuroses develop among many managers today. How can we reconcile the conflict between the two men who make up one manager, between the thinker and the doer?

Although we define management as getting things done through people we have varying concepts of what management does or should do. We usually think in terms of the functional approach, that is, management is the performance of the functions of planning, organizing, staffing, directing, and controlling or some other group of managerial functions.

Let's take a look at these managerial functions from the standpoint of the two main categories: Thinking and doing. Under "thinking," are planning and the more passive aspects of organizing, staffing, and controlling. Under "doing," come the more active phases of organizing, staffing, directing, and controlling.

To be effective a manager must have the vision to understand the multi-faceted aspects of business situations. He should be able logically to arrive at business decisions that affect the operations of the organization over which he has control. Taking available data, searching for the relevant, eliminating the irrelevant, weighing the alternatives, evaluating the results of the various alternatives, and trying to forecast into the future, the manager arrives at a course of action.

The Thinker

Certainly, it requires an exceptional amount of thinking ability to do this adequately. The higher an executive rises in the hierarchy of an organization the greater is the need for him to have vision and wisdom. To some extent this vision and wisdom is inherent in the successful manager and, to a limited degree, it can be acquired.

Dr. Kenneth McFarland has repeatedly said, "Think tall and be tall." To heighten one's vision and wisdom, it is necessary to think big. One tends to become what he thinks; therefore, if you want to become a person of wisdom and vision, it is necessary to think beyond the realm of the ordinary, the small, and the finite and to think in terms of bigness, breadth, and depth. Of course the manager must necessarily think in terms of the practical day-to-day aspects of his business. But even here—in thinking of the routine aspects of business—you can push your

"Lord, give me courage to change the things I can change; to accept the things I cannot change; and wisdom to discern between them" — The Philosopher's Prayer

If I were a lost horse where would I go?

thinking beyond the peripheral and envision possibilities and future ramifications. You can increase the scope of your knowledge by asking yourself what is just over the horizon, or just beyond the border of the immediate problem. Through repeated practice you will soon develop the habit of thinking in broader terms than just the immediate routine.

To gain the wisdom and vision available in decision-making you should try to obtain as many relevant data as you can concerning any problem confronting you. Quite often simple, basic facts are so obvious that we tend to overlook or disregard them. We may look to a more difficult solution to the problem because our comprehension is jaded. In essence, reasoned thinking means to: (1) utilize the facts available, (2) envision future consequences of a decision, (3) increase the scope of knowledge for wider understanding, and (4) be aware of the obvious but do not be controlled by it.

Besides the need to be a sound and logical thinker, the manager needs also a subjective feeling for people and for situations. Probably the word "empathy" best explains this other side of the manager's more passive role. In order to deal with rationally evaluating alternatives to reach a decision, you must have a feeling for a problem and the people involved. Haven't you heard of an executive who has a "feeling" for business? An individual may, after looking at the rationale, arrive at a decision based upon his feeling instead of, or in addition to, a conclusion logically derived from the facts. Particularly when the data are inconclusive, or when the logical answer based upon a rational analysis of the data appears to be erroneous, it is necessary for the manager to use feeling, or intuition, in his decision-making. He must on occasion use his vision to do what his rationale tells him not to do.

Probably the greatest need in the world today, from the managerial and non-managerial viewpoint, is to have an understanding of people. This must start with an understanding of yourself because true understanding of other people involves the ability to put yourself in the other person's position and think from his point of view. This can be called the "lost horse technique" of problem solving. With this empathy you have the ability to feel toward a situation as another person would feel toward the same situation so you know what an employee's reaction to a proposal would probably be.

The Doer

In a managerial position "faith without works is dead." Regardless of how much understanding a manager has, regardless of how much vision he exercises, unless he has the courage of his convictions and is willing to fight for what he believes in, then wisdom and vision are in vain.

You must be willing to take risks.

After a manager has reached a decision, he must have the courage to act to carry out this decision, unpopular though it might be. The courage required is not the blind, visible courage that permits a man to face physical danger unflinchingly. There is a courage, perhaps greater courage, which causes a man to face his fellow man and take action that is unpopular when necessary. It means you choose to stand up for your convictions even when it alienates the good opinion of your fellowman. Peter Marshall told the Senators of the United States, "Lord, give us courage to stand for something so that we will not fall for anything." It is also a good prayer for a manager. If one is to be a truly effective leader, he must have the courage to stand for the things that are "right" in his opinion.

In recent years management has tended to take a purely neutral position in its relationships with other people, and to adopt the so-called "do-good" attitude toward employees. This involves the use of committee assignments for handling managerial activities and making

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decisions that should be made by the individual manager. Today the movement is away from this type of leadership and back toward the more personal, individual, dynamic leadership where one man makes the decision, based upon advice of others, and then carries out that decision to its conclusion. I do not mean that management should become as autocratic and arbitrary as it once was. Nor do I mean that management should be as paternalistic as some managers were. However, management should not fear to take action that its logic and feelings dictate should be taken.

Using active courage does not mean to plunge ahead into a situation where there is bare hope of achieving any good objective. If the situation obviously cannot be cured and a basic principle is not involved, then the manager should exercise discretion to carry out his actions.

When you have made a decision to act remember that a manager must get things done through people. Here are two points to keep in mind. One is the tendency for Newton's Third Law of Motion to come into play when dealing with people: "For every action there is an equal but opposite reaction." Although this law is not universally applicable in dealing with people, it can be applied if considered in relationship to another law—the law of inertia. This says that "a body in motion tends to remain in motion and a body at rest tends to remain at rest until acted upon by an outside force." If a manager takes action without preparing his people for that action, he may encounter the law of reaction or the law of inertia. His people may react in the wrong direction or he may not get them in motion at all.

As a doer, a manager must be prepared to be responsible for his actions. He can not "pass the buck" to someone else but must be able to defend his course and accept the responsibility for its consequences. If this leads a man not to take action when he should, he hasn't the vital traits that make a manager. So to be a good manager you must develop the facility to decide and the courage to act. You must decide with empathy for your people and act in the interests of the whole organization even if it is an unpopular course. You must be what many would call a personality paradox—a thinker and a doer.

"A Little Knowledge ... is a dangerous thing." Acquire more by reading these:

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12. Toynbee, Arnold, A STUDY OF HISTORY, Oxford University Press.

13. Wulfeck, Wallace H., "The Buzz in the Executive Bonnet; Basic Principles of Behavior Dynamics," address delivered before the American Hardware Manufacturers Association, 1959.

■

About the Author

Dr. Leon C. Megginson, professor in College of Business Administration at Louisiana State University, joined the faculty in 1947. He received his master's degree and later his doctorate in management at LSU. Megginson attended Howard College and Mississippi College (BS degree) and did post doctoral work at Harvard University.

Dr. Megginson has served as a member of the Advisory Council of the Employment Security Division and on other community affairs. He is presently a staff consultant for City and Industrial Planners.

by E. E. Halmos, Jr.

Washington Course Points to Stiffer Controls

Out of more than 15,000 bills introduced during the 87th Congress, not a single measure specifically concerned with the oil and gas industry came up for final consideration.

There was ample discussion on Congressional floors concerning taxation, prices, appointments to regulatory agencies and the like.

Out of all this, our conclusion is the industry's future is cloudy, with the prospect of federal regulation getting stronger. The idea of public ownership of utilities and utility services has gained the ascendency in thinking in many quarters in Washington, and moves in this direction seem to be in the cards during the three-month interim between Congressional sessions, and probably in legislation next year.

Easiest way to look at what's developed is to take Congress, the new Administration and the regulatory agencies separately, and see.

Congress

Most of the battling that kept Congressional noses to the grindstone during one of the longest sessions in recent years centered on: (1) deep Congressional resentment of attempts to encroach on legislative prerogatives; (2) fear of loss of additional state and local rights to the federal government, and (3) a growing worry about the nation's financial condition.

Legislators slapped down—in quick succession—moves to bypass their own control, or states' rights, in such measures as the stream pollution control bill, the foreign aid bills, the so-called "wilderness" program, farm bills, before passing legislation in amended form.

Congressional worry over spending was always apparent — even though in the early "honeymoon" period the lawgivers gave the President what he wanted in the vast and confusing housing bill; and approved almost without dissent nearly $50 billion for defense and space-exploration purposes.

But elections are due next year—and it is now pretty well accepted that the federal deficit will run more than $6 billion when the current fiscal year ends next June. The whole House and about a third of the Senate will have to explain to voters why taxes stay high, the debt skyrockets, whether there's danger of inflation —and that's a sobering thought. So the effect will hold down big spending plans next year.

As to business in general Congress may also have opened Pandora's box when it passed the minimum wage amendments: By removing the previous requirement that an industry must actually be in interstate commerce before its workers are covered, and substituting only a dollar-volume test, many observers thought the legislators had now made it possible for federal agencies to regulate any business, simply by lowering the dollar-volume required.

Congress took no action (none was really expected this time) on matters such as depletion allowances that would directly affect the oil and gas industry; did, finally approve another study (by committees in both houses) of a possible national fuels policy.

The Administration

There were paradoxes in the new Administration's actions. On one side, the trend seemed to be more and more toward "public" decisions, more control of private industry, less and less leaning toward the business viewpoint. Yet there were a series of appointments that seemed to lean toward business.

In the Department of Interior, for example, one of Secretary Udall's first actions was to resurrect earlier dictums of the late Harold L. Ickes, definitely in favor of public power development and distribution.

The appointment of James K. Carr as Undersecretary of Interior (after a background of public-power service), and Kenneth Holum as Assistant Secretary (with a similar background in publicly-owned cooperatives), seem to reinforce the "consumer" orientation. Three of the appointments to FPC (there are now four—of

five—Kennedy appointees) also were from the "public" area.

But Wisconsin's liberal Senator Proxmire pulled a near-filibuster against four Kennedy appointees to important regulatory posts, on grounds that their business connections were too strong: John Connally as Secretary of the Navy; John Kelly as Assistant Secretary of Interior; Lawrence O'Connor as a member of FPC, and Jerome J. O'Brien as head of Interior's Office of Oil and Gas. All of these, said Proxmire, had a sinister oily connection.

And actions of some of the appointees were also paradoxical: FPC chairman Joseph Swidler, for instance, indicated he'd like to cut out much control and red tape for smaller gas producers, but indicated stronger control of the roughly 250 who produce more than 90 percent of the nation's total; at the same time he favored continuation of the area-pricing practices instituted a year ago.

Some Congressmen argued that FPC should continue utility-type controls instead. One (Rep. Charles Vanik, D. Ohio) called this a "sellout," threatened action to rewrite the Natural Gas Act to force continuation of utility-type controls.

The FPC

Biggest changes that will affect all aspects of the gas industry came in revamping of the internal operations of the Federal Power Commission itself.

At the beginning of the year, the commission adopted the practice of assigning individual commissioners the responsibility for preparation of opinions in big contested cases.

Later, FPC split its gas and electric regulatory functions, by establishing a Bureau of Natural Gas (instead of the former Bureau of Rates and Gas Certificates), and transferring electric rate functions to its Bureau of Power.

Further steps included changing name of the Office of Chief Accountant to Office of Accounting and Finance and transfer of its power functions to the Bureau of Power; and establishing a separate Office of Economics, reporting directly to the Commission.

This was in line with Presidential (as well as Congressional) pressure to speed up work of the regulatory agencies.

One regulatory agency that will bear close watch by the oil and gas industry is the Federal Trade Commission—a principal government arm (along with the Department of Justice) in anti-trust matters.

The agency itself has taken little new action (as of the end of September); but its new chairman, Paul Rand Dixon, has been making a series of statements that are considered alarming by main industry observers.

Meat of Dixon's comments has been: There's little or no price competition in the oil industry; bigness is a "real problem." He wants new legislation to curb price discrimination (S.11) and more power for FTC to seek temporary injunctions from courts, or to issue injunctions or stop-orders itself.

Legislative Picture

Conservative leaning of Congress and the eagerness of the new Administration to "make a record" on legislation affecting oil and gas that seemed fairly sure, prevented consideration of new legislation affecting oil and gas.

Next January, the legislative situation will be different (barring, again, a great national emergency). With elections upcoming, emphasis will be on local, vote-getting measures.

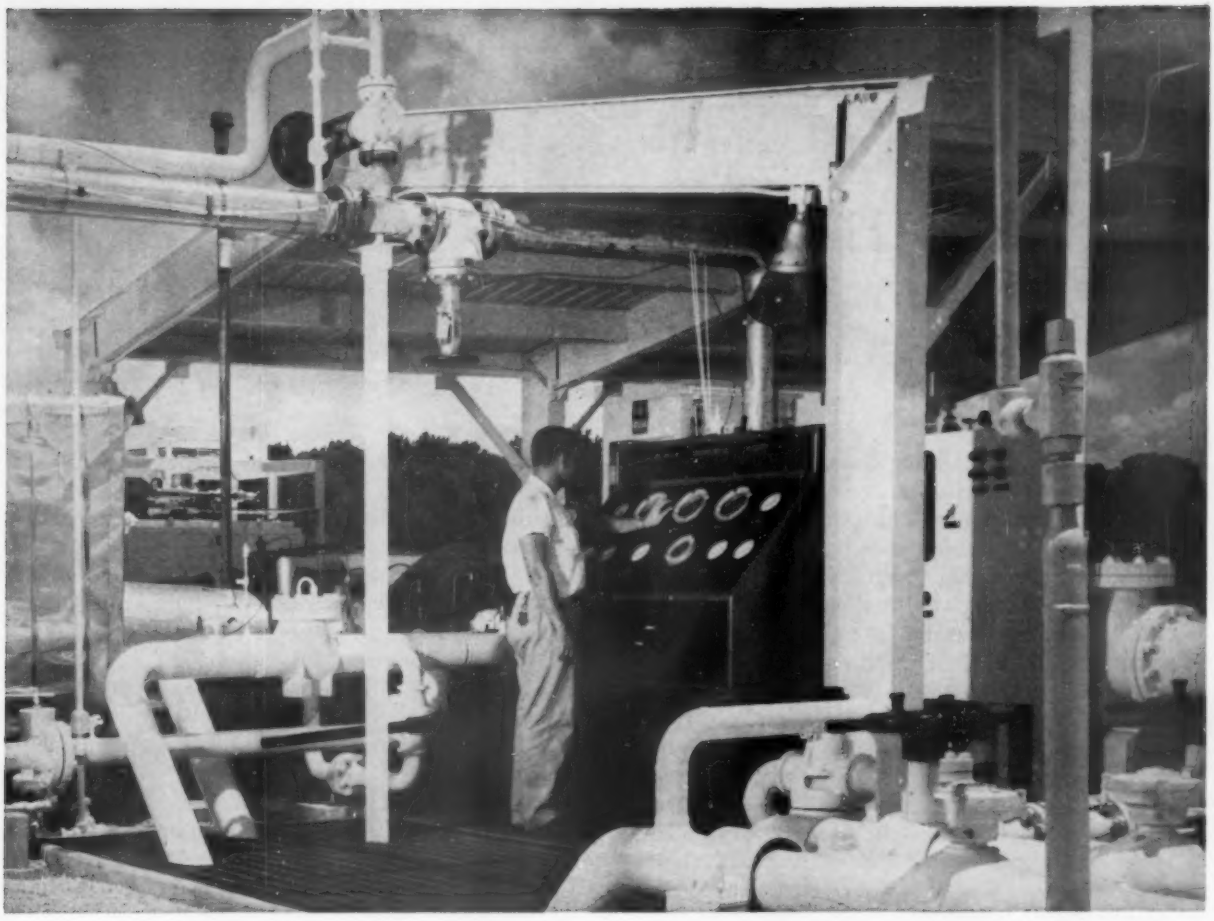
One of these, as always, is tax reform. For the oil industry, that means cutting percentage depletion — a subject not well understood by the general public and one easily converted into a popular idea for the individual taxpayer who thinks his own taxes too high, and industry's too little. Senator Williams (R. Del.) has already introduced his annual proposal to cut the 27.5 percentage depletion to 20% over three years. He got little support this time, might get some next session. Senator Gore (D. Tenn.) wants to chop the deduction completely.

FPC itself seems to oppose any new gas regulation next year. But there's growing evidence that Washington is beginning to think of pipelines in the same category once reserved for railroads—as a monopoly that must be contained with ever-tightening controls for the public good.

The Commerce Department is ordered to bring in a report before the end of the current year on a proposed national transportation policy—and this report will probably form the basis for any requests for a "Department of Transportation"—if the President decides to push for this sort of thing.

The federal-aid highway program has been taken care of for a two-year period (amply), and thus won't be up for argument next session. Further labor legislation (even though Labor got nearly nothing this time) is probably dead too—construction labor antics at missile bases left a very bad taste in Washington mouths.

What will happen to controls on residual fuel-oil imports is a matter of conjecture. As usual, northeastern Congressional delegations took up a lot of time complaining about the situation but Congress took no action. ■



Trunkline uses Solar Gas Turbine compressor in pipeline station

Currently "on-line" at Trunkline Gas Company's Cypress, Texas, pipeline compressor station is an 1100 hp Solar *Saturn* gas turbine-driven centrifugal compressor set. In this application, it pumps up to 60 million cu ft of natural gas per day.

At Cypress, Trunkline is helping to pioneer a new concept: the use of a high-speed, turbine-driven centrifugal compressor in the low-volume range. Traditionally, reciprocating equipment has been the most practical in the range from 75 to 1000 inlet cu ft per minute at up to 1500 lbs pressure.

However, the availability of industrial high speed drivers, such as the Solar *Saturn* T-1000 gas turbine engine, has provided the impetus for Solar to design and build a line of efficient, long-life centrifugal compressors for this range.

The Trunkline installation is 1/10th the size of conventional compressor sets, costs an estimated 2/3rds as much to install and will run on a variety of fuels. At Cypress, for instance, the Solar compressor set runs on natural gas from the line. It would also run on gasoline, diesel fuel, kerosene or LPG fuels.

Another advantage of Solar compressor packages is the fact that a complete turbine-driven 1100 hp unit weighs less than 10,000 lbs and occupies under 300 cubic feet of space. It is easily portable.

Solar compressors are also ideal for field boosting. One *Saturn* turbine-powered set will deliver as high as 100 million cu ft per day. A unique modular concept of interchangeable compressor staging allows quick, easy field changes to accommodate changing pressure and flow requirements.

Solar's industrial turbomachinery is designed for rugged use. Solar turbines start instantly without warm up and are ideal for remote or unattended operation. Ranging from 50 to 1100 hp, they can deliver more power per pound than conventional engines for pumping, electric power generation, oil well servicing and other prime mover requirements.

For more information about Solar turbomachinery, write Dept. J-160, Solar Aircraft Company, San Diego 12, California.

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Helium Waste Called Serious

James K. Carr, Under Secretary of the Department of Interior, is appealing to the gas industry to cooperate with the government in conserving helium. He spoke before the annual meeting of the Independent Natural Gas Association of America at Houston. He stated:

"The current waste of natural helium resources is a matter of great concern. More than four billion cubic feet is wasted annually, depleting our resources at a rate about ten times greater than present annual helium consumption. You men in industry know that helium has many more important uses than filling toy balloons and advertising blimps; for example — rocket and missile programs, nuclear reactor development, medical research, shielded-arc welding, low temperature research, and other scientific studies.

"I am happy to report that Secretary Udall has recently approved two contracts — the fulfillment of which will save during the next 22 years about 30 billion cu ft of helium. We feel these first contracts are real milestones in resource management and represent conservation in its truest sense."

Other than natural gas, only substantial source of helium is the atmosphere, which contains one part helium in 200,000 parts of air. Costs to extract are prohibitive.

Northern Natural Gas Company and Cities Service hold contracts to sell helium at about $11.24/Mcf to the government. Lately National Helium (Panhandle Eastern and National Distillers) signed a contract with the government to sell for $11.78/Mcf. A $25,000,000 plant will be built at Liberal, Kansas.

The new Helex plant of Cities Service will be built near Ulysses, Kansas. It is designed to process up to 505,000 Mcf per day natural gas. A cooling process is to be used to lower gas temperatures to some 260 deg below zero to separate helium from other constituents. Major equipment includes gas compressors, heat exchangers, external refrigerant compressors, a large steam boiler plant and a 25,000 gal per min water cooling tower.

In a press conference, Under Secretary Carr answered the following:

Q. Are any other contracts being considered?

A. We now have two contracts under negotiation besides the two signed. Out of $47,000,000 allotted by Congress for helium we still have $29,000,000 left. We'd welcome more applications.

Q. As I understand it eight others have made applications.

A. There have been 14 applications. We hope some of these will modify their approaches and bring them up-to-date.

Q. Would those who've already applied have preference?

A. No. All applications will be viewed on an even basis. We want to get in high gear. This is an important problem.

Q. What about other plants?

A. Bureau of Mines has plants and there's also a plant in Arizona. These plants are not very large and don't have any significant effect. They will not, I believe, be competitive.

Q. Doesn't helium production now more than meet demand?

A. Since future needs are judged to be much greater than present demand, plans for underground storage are under study. Only one storage unit is now in operation. This is near Amarillo.

"The helium program is one of special urgency and we invite gas producers to apply for contracts."

The Under Secretary is a professional civil engineer and former electric utility executive. A personable man, he stated firmly his belief that competition among fuels was the best way to get low cost energy to the consuming public. Just prior to his appointment in January 1961, to his present post, he was assistant general manager of Sacramento Municipal Utility District and served also as Chairman of the California Water Commission. ■

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by M. P. Murdock

Forecast: 1962 Demand Up 3.2%

The petroleum industry will have a better year in 1962. Total demand should be better than 10,000,000 b/d, which will be an increase of 3.2% over this year. Although the industry still is faced with many problems, I think the outlook for 1962 is better, and next year should be a good one for the U. S. oil industry.

This forecast for petroleum products was prepared after discussion with companies representing more than 75% of the U. S. oil refining capacity. Obviously, everyone was not in complete agreement, but this represents a good cross section of oil company opinion regarding the prospects for next year's business.

Let's take a look at our product categories. Gasoline is the largest volume product and accounts for nearly one-half total sales and for more than half the revenue. Of this 87% is used in automobiles, trucks, buses, airplanes, and other motor vehicles; 13% is used in non-highway engines, such as farm tractors, lawn mowers, motor boats, and stationary engines.

During the last couple of years, there has been a tremendous growth in the use of kerosine as fuel for commercial aircraft jet engines, in addition to space heating and fuel on farms. Today this accounts for about one-third of the kerosine used in the United States, and does not include fuel for military jet aircraft.

Distillates are heating oils. Also in this category are similar fuels used in large volume as diesel fuel for railroad locomotives, trucks, buses and other heavy duty engines.

Residuals are used by industry. Steel mills and other industrial plants use residual oil for fuel, and public utilities use it either on a regular or stand-by basis as fuel to generate electricity. This category also includes the so-called bunker oil for steamships.

Other products include the rest of more than 2000 products made from petroleum. Some are military jet fuel, liquefied petroleum gas, lubricants, asphalt and products used to manufacture so-called petrochemicals. The last now account for about 5% of total petroleum demand, and future growth is indicated.

The oil industry faces some serious problems.

1. There has been an over-supply of crude petroleum both here and abroad.

2. U. S. refining capacity is over-built and is still ahead of current demand. Only 82% rated capacity is in use.

3. The rate of growth of demand has slowed down, particularly gasoline and industrial fuels.

4. The U. S. oil industry is facing increased competition from natural gas, coal and low-cost foreign-produced oil.

In Table 1 you can see at a glance the 1960 demand, an estimate of the 1961 consumption based on 7 months and a forecast for 1962.

We forecast the increase on this basis: Demand for gasoline should be better next year due in large part to better business and industrial activity. There will be more people with more cars and more money to spend on gasoline.

Although rate of kerosine increase for 1962 will be lower than this year, the switch from piston to jet engines by the airlines is not yet complete. Improved business will mean more diesel fuel used by railroads, trucks and buses. Greater industrial activity will also bring residuals into the plus side.

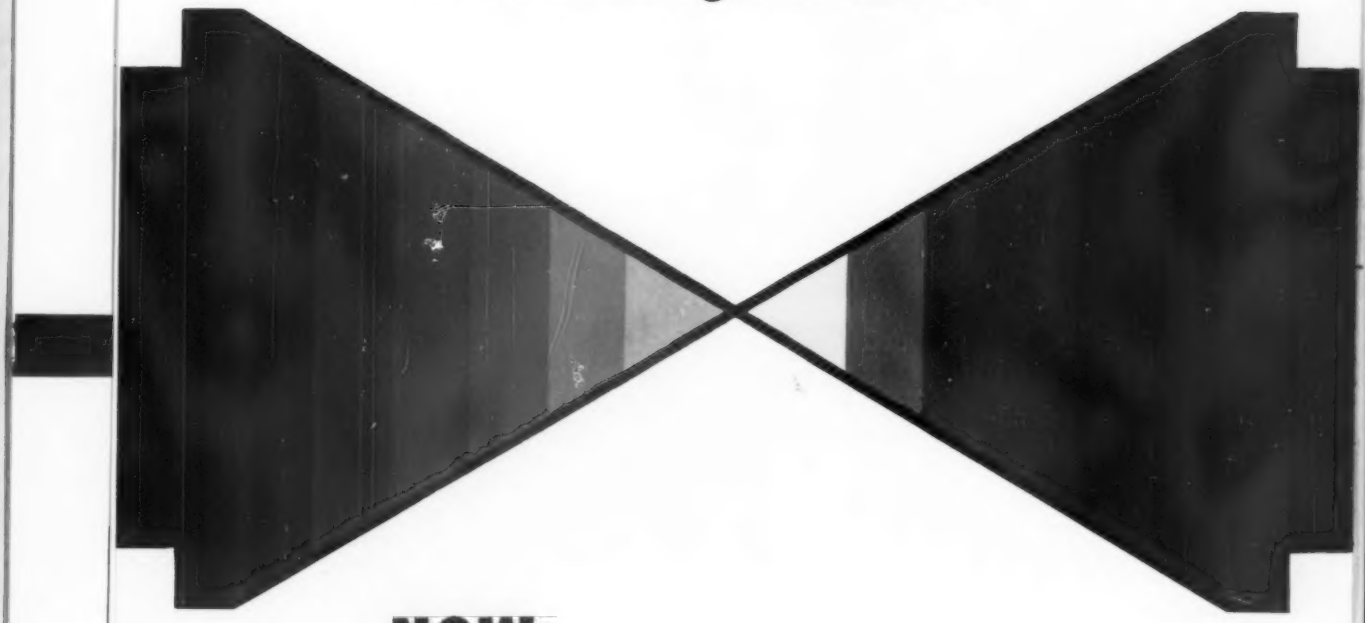
We expect a continuing growth in an already healthy demand in other products. Again, this is a direct result of expected better business generally, particularly in petrochemicals where many new manufacturing plants now under construction will start up in 1962.

Table 1. U. S. Demand for Petroleum Products

	1960 M b/d	1961 M b/d	% Change	1962 M b/d	% Change
Gasoline	4146	4186	+ 1.0	4305	+2.8
Kerosine	362	405	+11.9	435	+7.4
Distillate	1874	1900	+ 1.4	1938	+2.0
Residual	1531	1518	— 0.8	1555	+2.4
Other	1764	1840	+ 4.3	1935	+5.2
TOTAL	9677	9849	+ 1.8	10,168	+3.2

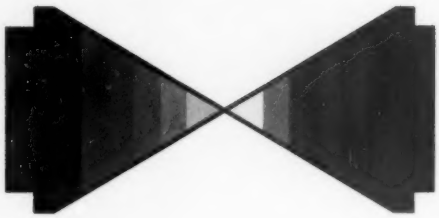
EDITOR'S NOTE: Condensation of a talk before the 9th Annual Marketing Conference, National Industrial Conference Board. Mr. Murdock is vice president-sales, Ethyl Corporation. ■

Some valves are designed
for the easy services...
the others,
for the tough ones...

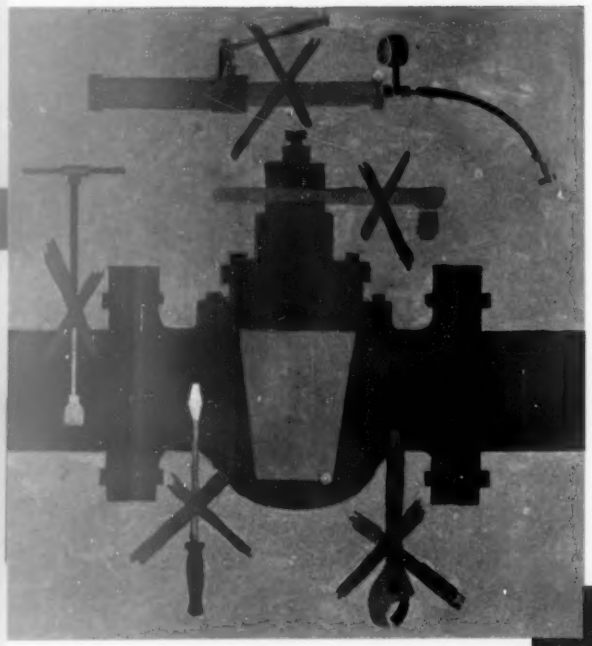


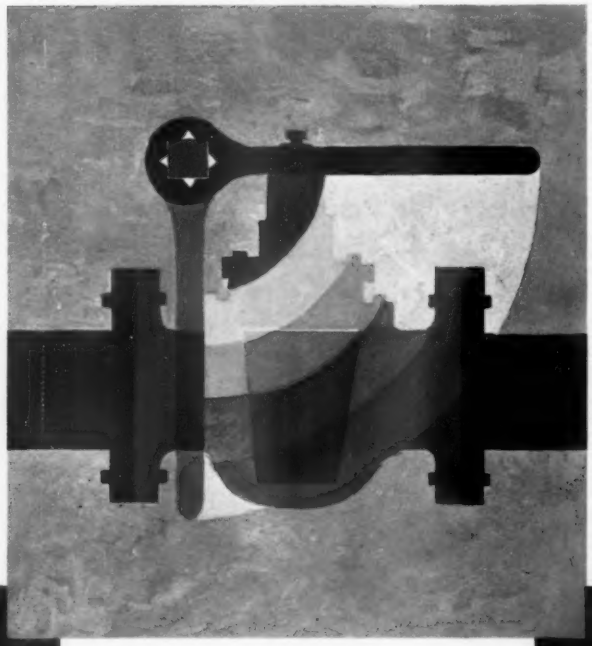
NOW,
ROCKWELL HAS DEVELOPED
AN EXCITING, NEW
CONCEPT THAT
SPANS THE SPECTRUM
OF VALVE SERVICES

THE NEW ROCKWELL PE



Now, in one
for versatile





Attention-Free Performance

Some valve users put a premium on a valve that can be installed and forgotten —that needs no attention. For many non-critical services, this kind of valve is adequate: the new Rockwell PERMATURN valves can be used in such services with no attention—and with excellent results.

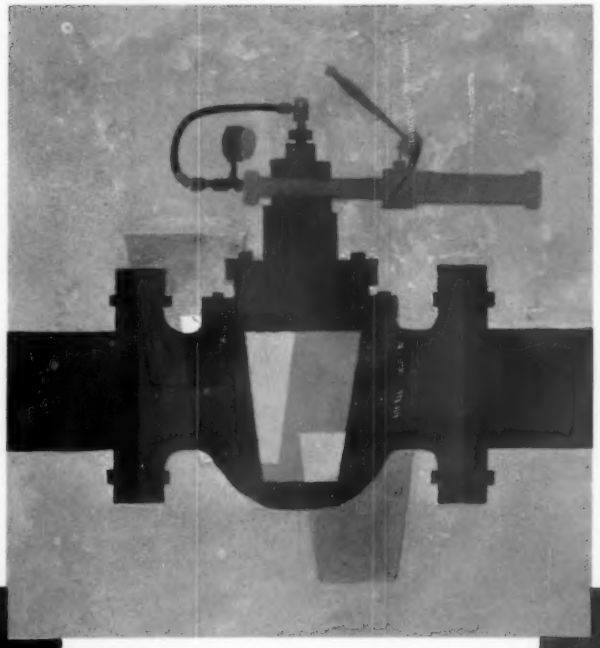
Easy 90°-Turn Operation

Fast opening and closing are easier with the new Rockwell PERMATURN than with any other valve ever developed. Just a quick, smooth quarter-turn from full-open to shut-off, and this unique valve design assures low-torque operation always—that's where the name PERMATURN comes from!

LIFT THESE PAGES for more information on this exciting new valve

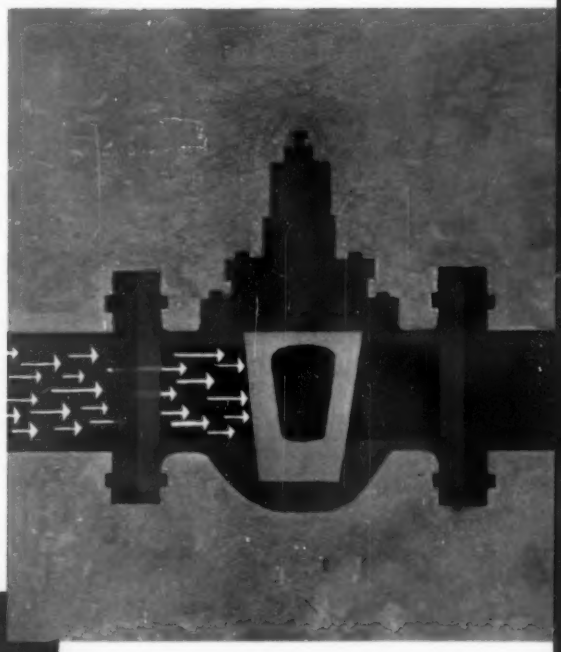
ERMATURN® VALVE DESIGN!

valve, you get all the features needed application to any fluid control service



Push-Button Seat Replacement

Here's a feature you'll find in no other type valve: you can put a new seating surface in the new PERMATURN valve in seconds, *without loosening a single bolt.* You can replace valve seats as often as you like—no more putting up with leaky valves. You add years of life—and save money—with this performance-extending feature of PERMATURN valves.



Drop-Tight Sealing

There are some valve applications where there's just no substitute for the bottle-tight, wear-defying characteristics of the new Rockwell PERMATURN valve used with a *regular program of sealant replacement.* And in these critical services, the PERMATURN valve has dramatically reduced operating torque requirements.

line!

THE NEW ROCKWE

available in all s

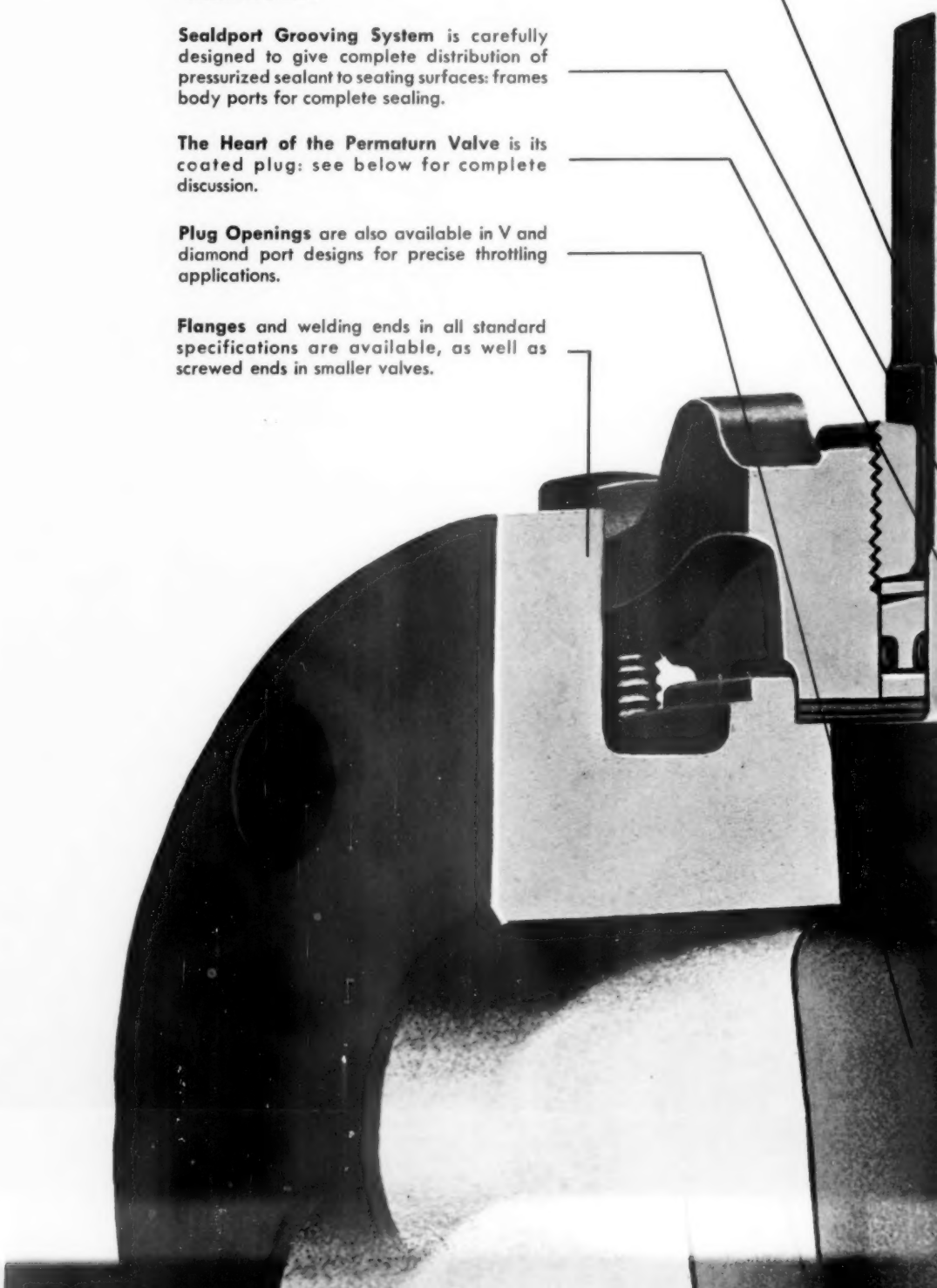
Double Ball-Checks maintain sealant pressure in the enclosed grooving system in plug and body and prevent back pressure on sealant chamber.

Sealdport Grooving System is carefully designed to give complete distribution of pressurized sealant to seating surfaces: frames body ports for complete sealing.

The Heart of the Permaturn Valve is its coated plug: see below for complete discussion.

Plug Openings are also available in V and diamond port designs for precise throttling applications.

Flanges and welding ends in all standard specifications are available, as well as screwed ends in smaller valves.

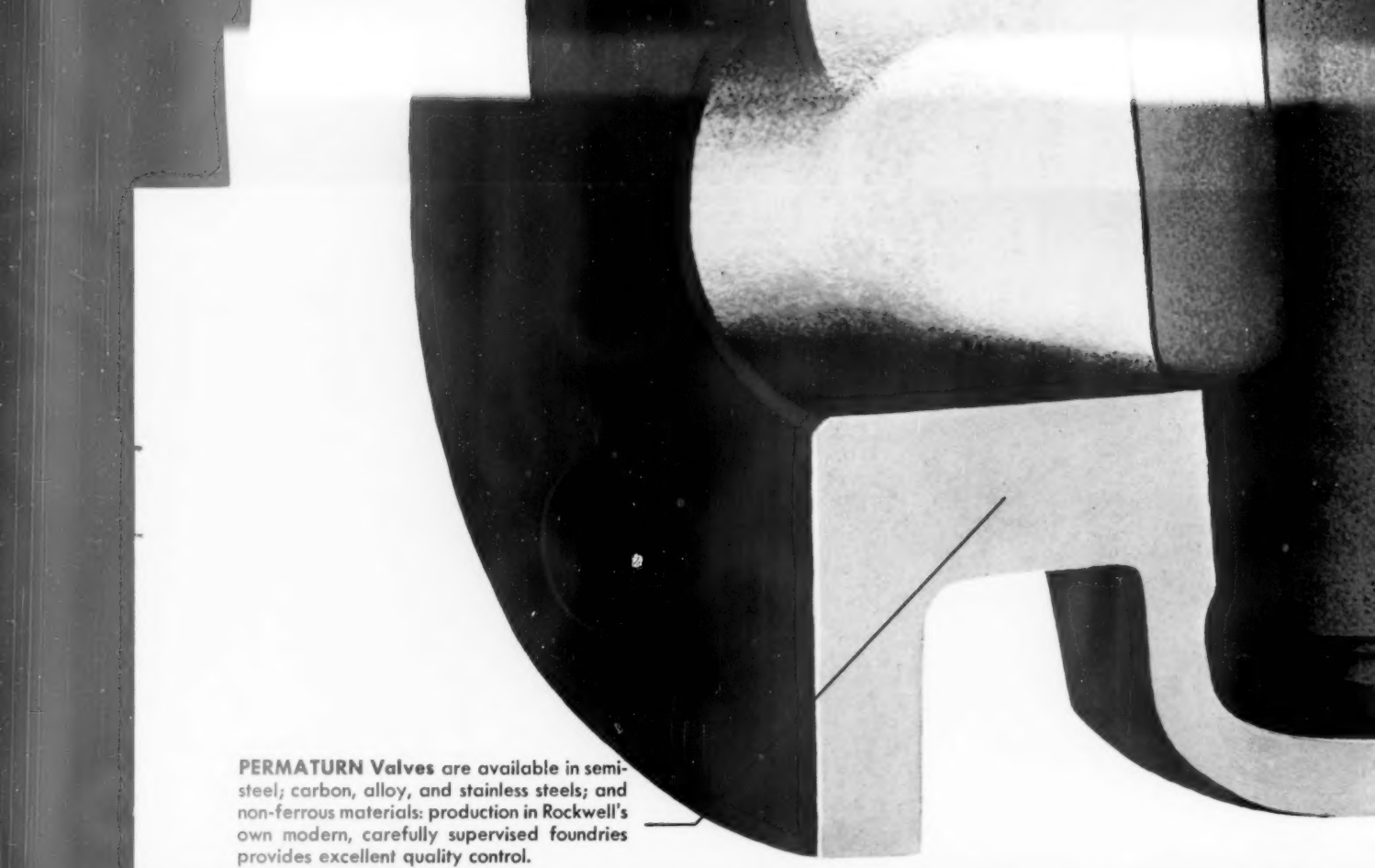


LL PERMATURN® VALVES

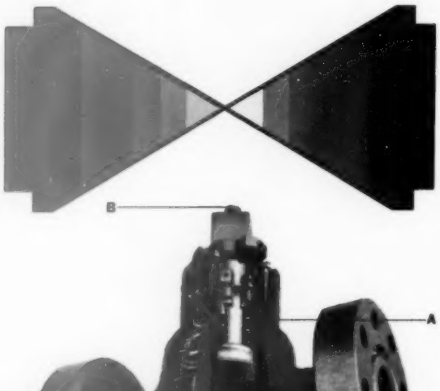
sizes for all pressures

Button-Head Fitting provides for simple, quick injection of plastic sealant into PERMA-TURN valves for instant seat replacement. Fitting also serves as compression screw when sealant is used in stick form: can be removed under pressure.

Fixed Adjustment Assembly is set at the factory for proper sealing fit and operating torque: requires no further adjustment or attention in the field. (See detail) *Slotted gland* is set at factory for proper compression of *spring washer(s)*. *Washer(s)* flex slightly (.001") to allow plug to lift when pressurized sealant is injected. *O-rings* seal against leakage.



PERMATURN Valves are available in semi-steel; carbon, alloy, and stainless steels; and non-ferrous materials: production in Rockwell's own modern, carefully supervised foundries provides excellent quality control.



Rockwell PERMATURN valves are also available in the inverted plug Hypreseat® design for high pressures. Low torque operation is assured by plug coating of high lubricity and bearing-guided stem. Other features are plastic stem sealing (A), fitting for "push-button" seat replacement (B), and thrust assembly (C) for controlled plug adjustment.

The secret of the PERMATURN® valve's

The unique design feature that makes the Rockwell PERMATURN valve line applicable to all valve services is its coated plug.

Developed after five years of extensive testing, the coating has an extremely low coefficient of friction and is applied in such a way that it is *permanently bonded to the metal surface of the plug.* This tenacious lubricating film gives *permanent separation of metal surfaces* of plug and body: the valves literally cannot stick or freeze.

The inert nature of the plug coating assures permanent lubricity for easy, sure operation of the PERMATURN valve at all times. Combined with the many other new design features described above,

the plug
valve the

Attentio
fluids ha

Easy, 90
even whe
tion are i

"Push-Bu
usefulness

Drop-Tig
this featu

Structural Design of the PERMATURN valve is the strongest of any valve available today: body ribbing gives complete freedom from distortion at rated pressures and temperatures.

Rockwell versatility...

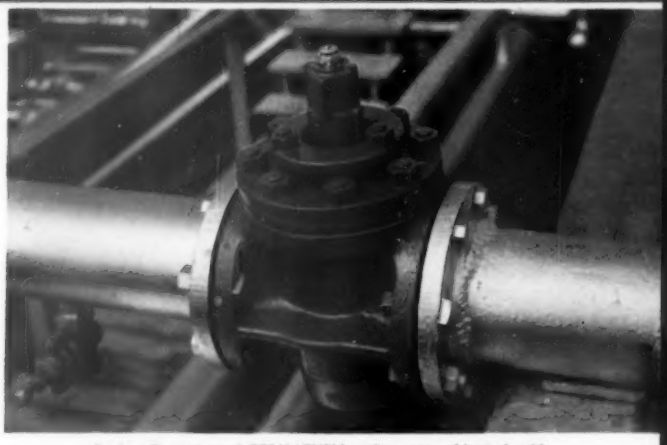
coatings give the Rockwell PERMATURN ese versatile application benefits:

on-Free Performance in services where ndled do not require a special valve.

0°-Turn Operation in all valve services, ere remote operation or infrequent atten- involved.

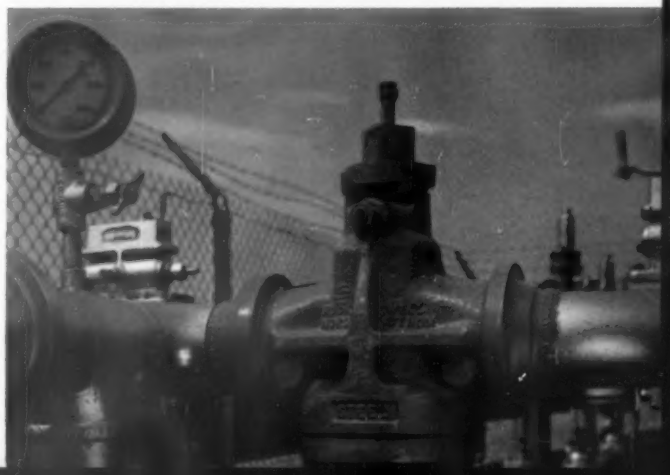
utton" Seat Replacement extending valve s without costly downtime and maintenance.

ght Sealing for critical applications where ure is all-important.



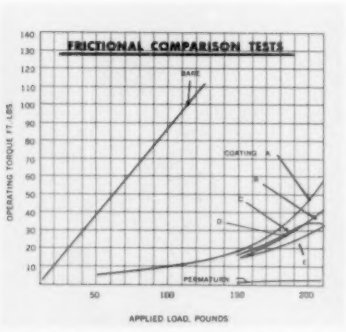
Rockwell semi-steel PERMATURN valves are shipped with a distinctive red primer paint that has wide compatibility.

Steel PERMATURN valves are given a gray prime coat: both colors give good corrosion-protection in storage and in service.



Only Rockwell, world leader in valve research, could have developed the **PERMATURN®** valve

For more than forty years, Rockwell has pioneered in valve research. This background of experience, which made the Rockwell-Nordstrom lubricated plug valve the world's standard of quality, led to the five year development program on the PERMATURN valve, a new concept in versatile, all-purpose valve design.



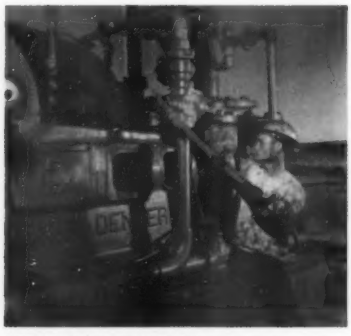
Part of this study concerned the various characteristics of many compounds considered for the plug coating medium. Exhaustive mechanical and chemical resistance tests, and carefully measured frictional comparisons, led to the selection of a material which has proved its ability to stand up under tough service for years of normal valve operation.

Complete production facilities for the new PERMATURN valve have been installed at Rockwell's nationwide valve manufacturing plants. The equipment shown above was specially developed to coat the plugs of Rockwell PERMATURN valves on a production line basis and is typical of installations at other Rockwell plants.

Rockwell PERMATURN® valves have been customer-proved before introduction

NO ATTENTION has been given these Rockwell PERMATURN valves on hydrocarbon service in the year and a half since their installation. Operation is positive and easy—and shut-off is still as bottle-tight as the day the valves were installed.

JET FUEL is handled by these Rockwell PERMATURN valves, in service since 1960. Operators have found the plug coating of PERMATURN valves gives smooth, easy operation—and has reduced sealant injection needs from once-a-week to once every three months.



SURE OPERATION on tough services has been proved by pilot installations of PERMATURN valves across the country. The coated plug supplements a regular program of sealant replacement, needed in these services for long valve life, to assure low-torque operation at all times.

Rockwell Manufacturing Company
Pittsburgh 8, Pennsylvania

I'd like to have your "Pocket Valve Guide" with brief specs and coverage charts on Rockwell PERMATURN valves.

Name_____ Title_____

Firm_____

Address_____

City_____ Zone_____ State_____

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another fine product by
ROCKWELL

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by W. Dow Hamm

Precepts of Management

Over and above the programs we have planned for company operations, I would like to review some qualities of management people we seek.

1. Integrity: Any company or organization must have a high ethical and moral standard. Actions of our people should create, in the minds of people in the industry and in the communities in which we live, a legend of integrity. We must abide by the laws of our land. Atlantic has never, and will not condone anything of an unlawful or shady nature.

2. Religion: Religion is a powerful force in the lives of human beings, and while I am not encouraging people to be religious fanatics, I sincerely believe that people who attend church develop a poise and balance that is of great importance.

3. Humility: In our search for leadership in Atlantic, we have selected people who we believe have the abilities to do the job, but at the same time we want people who in their dealings with others respect the dignity of all people.

In many parts of the oil business our people come in contact with independent operators, major company employees, and citizens of the communities where we may be working. Every Atlantic office should greet all visitors in a pleasant manner, and someone should meet with them and handle their business promptly. It is not good taste to leave visitors on the waiting bench for an hour or two.

In our dealings with both independents and major company representatives there is always give and take. We should, of course, try to negotiate to Atlantic's benefit, but on the other hand, we should not build up a reputation of being contentious in minor details.

4. Flexibility: One of the great problems in administration of affairs in major companies is the difficulty of creating an understanding of flexibility among managers at various levels. Naturally, we must have programs and budgets which will be made up after a lot of serious study, and such approved programs we do intend to carry out, but we must be mindful of changing events and new opportunities which may not have been known at the time a program and budget was developed. No program is so perfect that it is not subject to change when there is good cause.

5. Research Oriented: The oil industry is always going through a revolution, and will continue to do so. This is good. Our current oversupply of oil has forced operators everywhere to search for new, more efficient methods. Some of these improvements will come from our own research, some from industry research, and some will come from ideas generated by us and the people who work for us. We must not be adverse to change.

6. Read: We live in a fast changing world. Accordingly, may I suggest to you — read, read, read. You will generate, through reading, many new ideas — you will not merely keep up with the parade, but will get out in front.

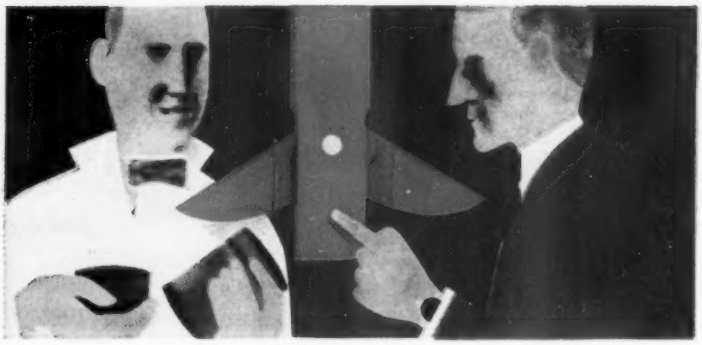
7. Good Citizenship: Participate in community and industry activities within your area. It takes some free time, but it makes you and your company important in the eyes of the community.

8. Goals: I believe in setting our target high and trying to make it. Even though we might fail from time to time, striving for the high level will make us do better. Your goal should involve substantial growth.

Each of you managers will be setting for all of your employees not only the moral tone for those under your supervision, but a pattern of aggressiveness, ingenuity and flexibility that will radiate down through your organization. If we can do all of these things we will indeed create and perpetuate a great company where there will be many interesting jobs around the world.

EDITOR'S NOTE: These "precepts of management" were taken from remarks made by Mr. Hamm, Atlantic Refining Company's vice president and general manager of production, at a managers' meeting. ■

NEW UNDERGROUND SUPERHIGHWAY



Read how Gulf's Single-Point Entry Technique for fracturing gives up to 100 times the fracture capacity of conventional fracturing... offers you precision placement and increased drainage, too.

GULF

Perhaps you have used hydraulic fracturing successfully. It has helped many oilmen jump well production to 5 and 6 times the usual bbls./day.

For a dozen years now, the basic technique of pumping fracturing fluids down the well bore under pressure to stimulate the flow of oil has been modified and improved.

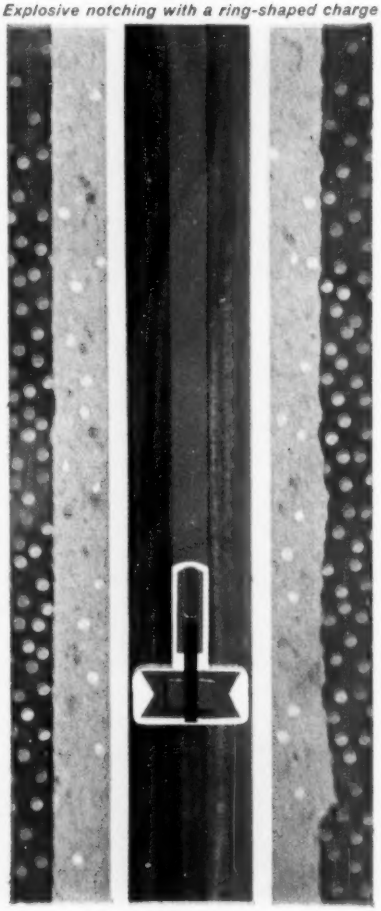
But this conventional fracturing has its limitations. The industry has known this for a long time. At best, it is hit-or-miss. You can end up throwing several thousand dollars down a hole.

More often than not, you may be limiting your profits when your pay zone is thick or of low permeability.

It's also true that fracturing can give you disappointing results in a thin zone if the location of the fractures isn't right.

The scientific answer. Now, out of studies of fracturing at the Gulf Oil Corporation's Harmarville Research Center, comes an altogether new approach. One that all but takes the "miss" out of well stimulation.

Explosive notching with a ring-shaped charge



For Gulf's development isn't just another technique. It is a precision system for fracturing. It replaces great gaps in our knowledge of fracturing with a painstakingly developed and tested body of scientific facts. It brings new ideas, new tools into play.

Our name for this precision system is Single-Point Entry Technique for fracturing.

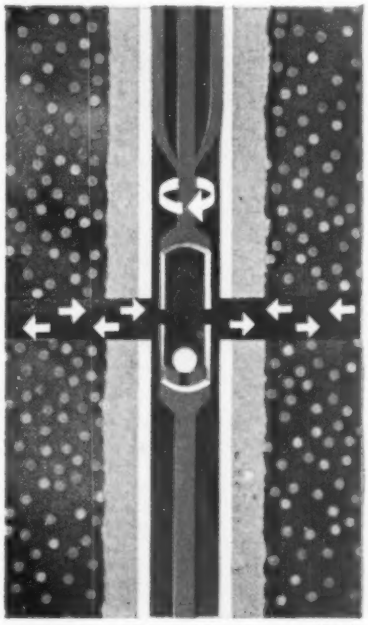
Up to 100 times the fracture capacity. Twenty-four service companies have already become Gulf licensees. In their hands, Single-Point Entry Technique for fracturing has already proved itself to be all our studies showed — and more.

One, it stimulates wells on jobs where conventional fracturing wouldn't even be worth a try. In itself, this characteristic moves

fracturing a long step ahead.

Two, Single-Point Entry Technique for fracturing usually outstimulates conventional fracturing techniques.

In both cases, Gulf's new system gives up to 100 times the fracture capacity of conventional fracturing. It has actually pushed productivity beyond the most hopeful expectations. In some cases, 20, 40, 60 times.



Hydraulic notching with an abrasive fluid

This system gives you all 3. Why does Gulf's new system give so much more than conventional fracturing? Because no conventional technique offers this scientific, systematic, 3-step approach: (1) precision fracture placement, (2) high fracture capacity and (3) an adequate reservoir drainage system.

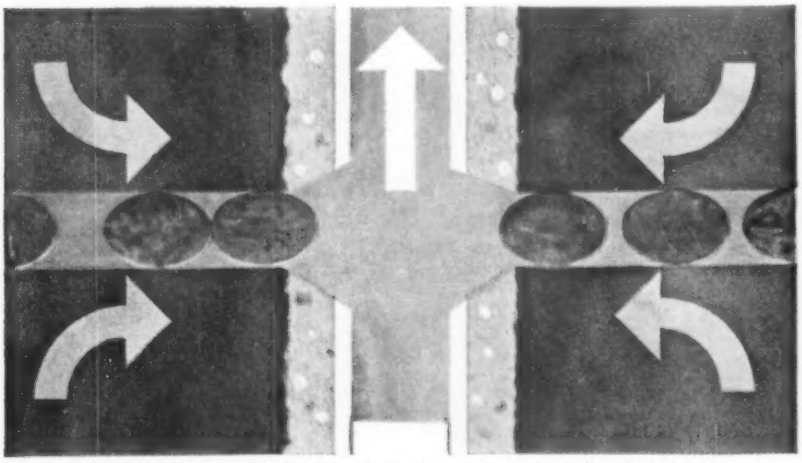
Now Single-Point Entry Technique for fracturing is available to boost your well flow levels. To pay you a sizeable number of bonus benefits as well. To improve reservoir drainage, for one. To lessen pressure drawdown. To lower gas-oil ratios. To minimize water coning. To make work-overs simpler.

"Superhighway" for oil. No more hope-for-the-best fracture location. In Single-Point Entry Technique for fracturing, any one of three tools cuts the notch precisely where reservoir study says it should.

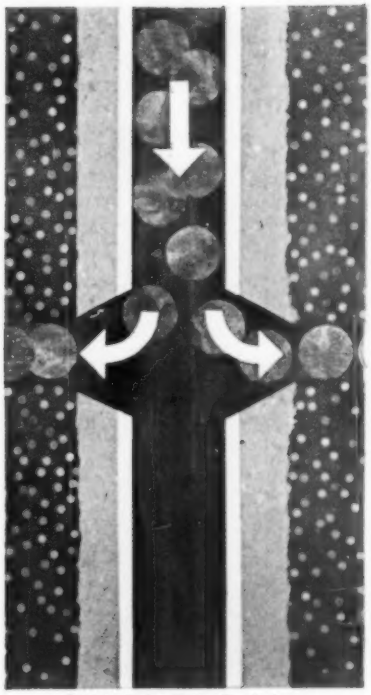
These tools include a mechanical cutter, a hydraulic notcher which jets an abrasive stream, and a ring charge for use in explosive notching.

No more helter-skelter fractures with Single-Point Entry Technique for fracturing. In their place, a single large "superhighway," extended deep into your pay zone.

And no more inadequate drainage. Your large fracture area and carefully prescribed propping agents assure that.



Production by way of high-capacity fracture—propped with "walnut shells"



Single-Point Entry Technique

Just contact these licensees. It's so easy to have the Single-Point Entry Technique for fracturing custom-fitted to your well-stimulation needs. Simply contact any one of these Gulf licensees:

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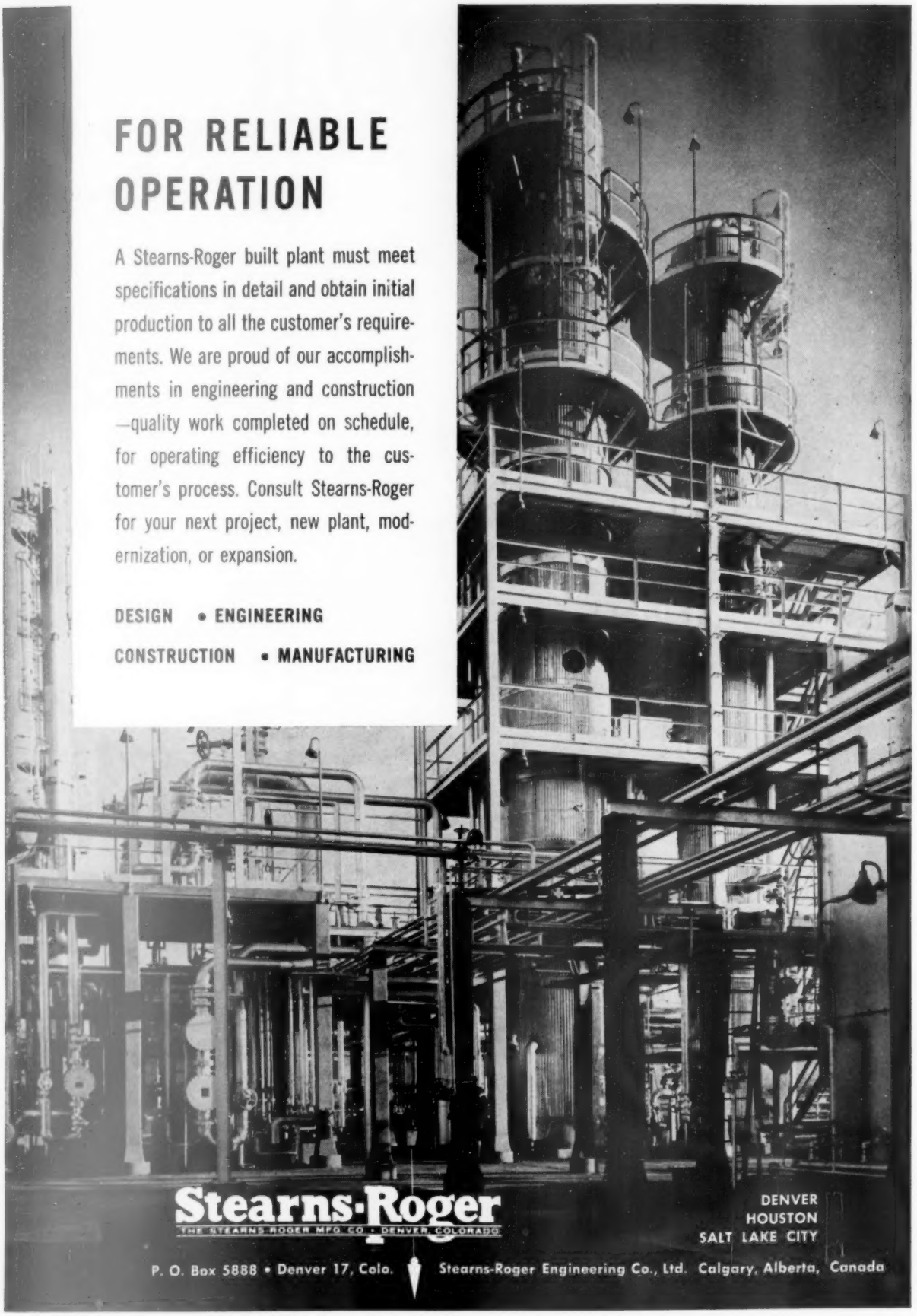
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Management People

F. B. Ingram, president of Ingram Barge Company and executive vice president of Ingram Oil and Refining, was elected a director of Murphy Corporation. Ingram recently merged with Murphy.

W. M. Elmer, president of Texas Gas Transmission Corporation and chairman of the board, Texas Gas Exploration Corporation, was elected president of the Independent Natural Gas Association of America. He formerly was first vice president and succeeded W. E. Mueller as president.

Lawrence H. Gall was named executive director of the association. He has been acting executive director and succeeded John A. Ferguson, who retired and currently serves as consultant to the board of directors.

Four executive and managerial changes of Ohio Oil Research Center are: Dr. L. C. Gibbons, formerly supervisor of the chemistry department, was promoted to associate research director; Dr. R. D. Russell, former geology department supervisor, became manager of the new geology and geochemistry department; R. B. Rice, physics department supervisor, was named manager of the new physics and mathematics department; and Dr. F. H. Poettmann, engineering department supervisor became manager of the new engineering and chemistry department.

Alpheus C. Beane, senior partner of J. R. Williston & Beane, New York investment banking firm, was elected a director of the Wichita River Oil Corporation, an oil and gas producer with headquarters in Wichita Falls, Texas.

Ohio Oil announced some appointments to its newly-created international organization. William K. Tell, general attorney and member of the legal staff, was given responsibility for the legal aspects of the international operations. Kenneth M. Burns, assistant controller, was named to direct the international group's accounting work. Elmer A. Graham, assistant treasurer, is responsible for financial activities of the international operations. He has served in Ohio Oil finance posts in Libya and Guatemala.

Dr. Romulo Quintero, Venezuelan chemical engineer, was appointed manager of manufacturing and a director of Mobil Oil Company de Venezuela. He has been superintendent of the gas department in Anaco, assistant to the general manager, and assistant manager of supply and distribution.

R. Quintero

A. Stebinger

Arnold Stebinger was appointed international government relations advisor in the new government relations department of Socony Mobil Oil Company. The department was established October 1, with Christian A. Herter Jr., as general manager. Stebinger was former regional vice president (Far East) of Mobil International.

Dr. Neil V. Hakala was appointed managing director of Esso Research Ltd., Abingdon, England, and also elected to the board of directors. He has been serving as deputy to the vice president of Esso Research and Engineering for petroleum products, medical, basic and analytical research. William E. Lifson, former special assistant, became acting deputy for these activities Hakala succeeded C. S. Windebank who became vice chairman of Jersey Standard's "new uses" activities in New York City.

Robert O. Jennings was appointed vice president of Signal Oil and Gas Company. He joined the company as general manager of crude oil purchases and sales and supply and transportation, and continues in that capacity. In former positions he has been a general consultant in the petroleum industry, and manager, supply and distribution, for Gulf Oil.

Roger Swenson was named assistant treasurer of Union Texas Natural Gas Corporation. He formerly was with the Slick Oil Corporation of Houston.

Fred H. Warren, formerly senior planning associate for Ohio Oil was named manager of the forward planning division. He is responsible for managing the division concerned with the recommendations for the company's long range goals and activities.

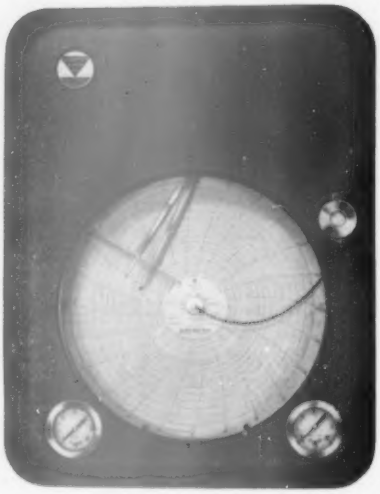
George S. Eccles was named a director of Canadian Husky Oil, Ltd. and its subsidiary, Husky Oil Company of Cody, Wyoming. He is president of First Security Company and First Security Investment Company.

E. Odell Campbell, formerly manager of products movements, forecasts and purchases for Kerr-McGee Oil Industries, was transferred to Golden, Colorado as administrator of the metallurgical research laboratory there. Thell C. Woods, former process superintendent for the Kerr-McGee refinery in Cushing, Oklahoma succeeded him.

Howard W. Bell, after seven years service with the Iranian Oil Consortium in Abadan, Iran, was elected assistant treasurer of Standard Oil of California. He has served with the company's pipeline department in various accounting and administrative capacities.

John Sidney Smith, Sun Oil Company production department public relations representative, was transferred to Philadelphia from Dallas. He took an active part in Texas Oil Information Committee. His assistant, Walter M. Sanford, was placed

SERIES A-88 CONTROLLERS



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in charge of the Dallas office. He handles public relations, under Smith, for Sun's Gulf Coast and Southwest Production Divisions and Sun Pipe Line Company.

G. R. Preston

G. R. Preston was elected a vice president of Cities Service Petroleum Company. Most of his experience has been in the treasurer's division and he continues as a director and treasurer.

James E. Chaffin was appointed to the newly-created post of safety director in the industrial relations division of the company. He has many years experience in pipelining and pipeline management and was former assistant general superintendent of the company. George F. Hall Jr. was appointed general traffic manager in the supply distribution division. He replaced L. C. Davidson who took a leave of absence. Hall was formerly assistant traffic manager.

Matthew V. Carson Jr., director of the Office of Oil and Gas, Department of the Interior, was elected a vice president of Sinclair Refining Company. He was the first administrator of the mandatory oil import program. He replaced Orville D. Judd, vice president, who has represented Sinclair in Washington since 1951.

Fred C. Boucke was appointed assistant to the chairman of the board, Standard Oil of California. He has been serving in London as president of Iran California Oil Company, subsidiary which manages Standard's 7% interest in the Iranian Oil Consortium. E. Perrin Fay, previously assistant manager of Standard's Eastern Hemisphere operations staff, succeeds him as Irancal's president.

John H. Thacher was appointed to a new executive assignment in the management of Standard Oil of California with responsibility over the company's interests in the Huntington Beach Company and the Elk Hills Naval Petroleum Reserve. He became executive vice president and director of the Huntington Beach Company.

Z. D. Bonner, formerly Far East manager, was named manager, crude oil department of Gulf Eastern Company in London, England. He succeeds F. R. Drury, who was transferred to Gulf's general office in Pittsburgh where he assumed general staff duties in the crude oil department.

John G. McLean, financial vice president of Continental Oil Company, was elected a director and vice president for international and financial activities. He assists A. W. Tarkington, senior vice president of international operations and finance. McLean has served as a management consultant to major industrial organizations.

G. F. Bassler was promoted to manager of personnel relations for Continental's international operations. Formerly assistant to the general manager of manufacturing, Panama operations, he succeeds Sam W. Leonard who was named controller, assistant treasurer and secretary of Petroquimica Argentina, S.A. (PASA), Buenos Aires, an affiliate of Continental.

Dr. W. O. Armstrong, medical director for Conoco and a pioneer in the field of occupational and pre-

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ECONOMICS OF PETROLEUM EXPLORATION, DEVELOPMENT AND PROPERTY EVALUATION

Prentice-Hall in Cooperation with the Southwest Legal Foundation

PRESENTS AN AUTHORITATIVE REPORT ON THE LATEST DEVELOPMENTS IN PETROLEUM ECONOMICS.

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EXPLORATION FOR STRATIGRAPHIC TRAPS — A. I. Levorsen, Consulting Geologist, Tulsa

REDUCING OIL-FINDING COSTS BY USE OF HYDRODYNAMIC EVALUATIONS — Gilman A. Hill, President, Petroleum Research Corporation

REDUCING HIDDEN EXPLORATION COSTS — D. M. E McLarty, Petroleum Consultant, Denver

PROBLEMS OF FOREIGN EXPLORATION — John C. Dunlap, Consulting Geologist, Dallas

CUTTING COSTS OF WELL COMPLETIONS AND OPERATIONS — Marion H. Stekoll, President, Stekoll Petroleum Company

THE PROFITABILITY OF PROPOSED EXPLORATORY VENTURES — J. J. Arps, Vice-President, British-American Oil Producing Company.

FINANCING PROPERTY ACQUISITIONS — Eugene McElvaney, Senior Vice-President, First National Bank in Dallas

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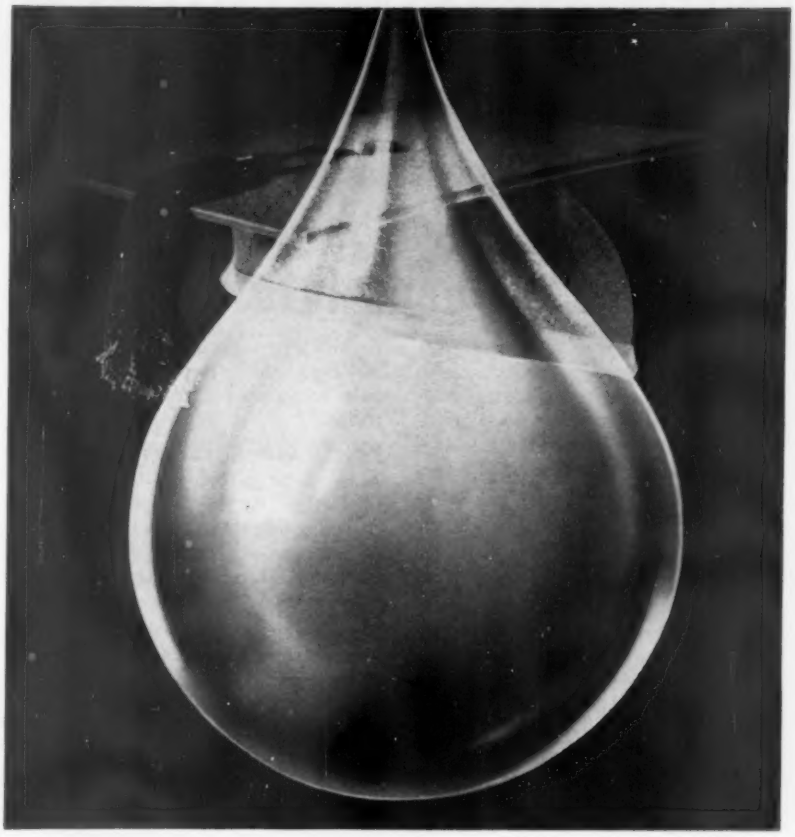

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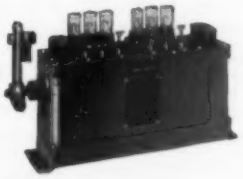

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Corrosive Water Fight Can Be Lost Before Pipe Goes Into the Line

Litewall steel pipe, cement-mortar lined, is proving highly successful in resisting the corrosive effects of oil-field brines in water flood installations and waste water disposal lines. But the record is marred by occasional puzzling failures—which have only lately been traced to an unsuspected source!

DANGER!

In most instances of failure, the trouble has been caused by out-of-round pipe—pipe which has lost true concentricity and straightness between the pipe mill and the lining plant. It is extremely difficult, if not impossible, to apply a cement-mortar lining of uniform thickness and density to pipe which is out of round by more than 1%, or whose straightness varies more than ⅛" in 10 feet. Litewall pipe can easily depart more than this from true dimension during shipment from pipe mill to lining plant. When this happens, the fight against corrosion may be lost before the pipe goes in the line.

SOUTHERN PIPE SOLUTION

Cement-lined litewall steel pipe from Southern Pipe has been developed to protect oil field lines against this hazard. Southern's Cemcote Steelcor pipe is manufactured to rigid specifications. It is lined with a dense, uniform coating with no zone of weakness.

True pipe dimensions are held at every step to insure against "out-of-round" pipe failure, because Southern Pipe fabricates its own pipe to help you whip the problem of corrosion.

PROPER CEMENT IMPORTANT

Many cements provide incomplete protection. Southern Pipe matches its cement-mortar linings to the particular type of corrosion which will be encountered in the specific application.

Southern Pipe uses one of several special cements with a low content of tricalcium aluminate, and one with zero tricalcium aluminate.

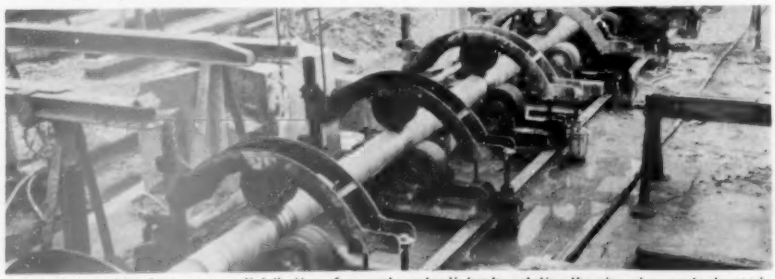
Reason?

Sulfates in the brine react with the calcium hydroxide in the cement, forming a compound which in turn reacts with tricalcium aluminate to form an expanding compound which causes rapid mechanical deterioration of the lining, with consequent corrosion and line failure.

LONG-RANGE INVESTMENT

Your initial investment in Southern Pipe's "packaged" line (one manufacturer, one responsibility) may be a little higher, due to freight from California, but on a long term basis your costs will go down. Why? Southern Pipe's cement-mortar lined litewall steel pipe goes into the line to *stay* – less replacement, less downtime, lower labor costs, fewer service interruptions.

Dollar for dollar, the soundest "corrosion-free" investment in pipe you can make is Southern Pipe.



Spinning machine insures even distribution of cement mortar lining by rotating the pipe at a constant speed.

ventive medicine, retired September 30. He organized and developed Continental's medical program and has been the firm's medical director for 32 years. Dr. Robert R. Dugan, former assistant medical director, succeeded him. Dr. Lembke, staff physician, succeeded Dugan as assistant medical director.

Paul L. Fahrney and Elmer R. Peterson were elected vice presidents to the board of directors of Standard Oil of California. Fahrney has been vice president responsible for national marketing policies and Peterson has been vice president in charge of financial affairs.

E. L. Stauffacher, vice president of Cities Service Company, was named coordinator of light end products. He is assisted by G. C. Richardson who stepped up to the position in the parent company organization from managership of the supply and distribution division.

Statement Required by the Act of August 24, 1912, as Amended by the Acts of March 3, 1933, July 2, 1946 and June 11, 1960 (74 Stat. 208) Showing the Ownership, Management, and Circulation of

PETROLEUM MANAGEMENT

Published monthly except semi-monthly in July at Dallas, Texas for October 1, 1961.

1. The names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher: The Petroleum Engineer Publishing Company, 800 Davis Bldg., Dallas, Texas.

Editor: J. E. Kastrop, 800 Davis Bldg., Dallas, Texas.

Business Manager: Joe B. Woods, 800 Davis Bldg., Dallas, Texas.

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member, must be given.)

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Reserve Life Insurance Company, 403 South Akard St., Dallas, Texas.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

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4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiants full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required by the act of June 11, 1960 to be included in all statements regardless of frequency of issue.) 4,297.

Joe B. Woods, Business Manager.

Sworn to and subscribed before me this 28th day of September, 1961.

(SEAL) Lillian H. Johnston
Notary Public, Dallas County.
(My commission expires June 1, 1963)

Officers of Desk and Derrick for the 11th year are: Mrs. Bettie Conley, (Wm. Helis, New Orleans) 1961 president, serves on board in 1962; Mrs. Viola L. Rembold (Minerva Oil Company, St. Louis), treasurer; Mrs. Lona Mae Forwald (Gulf Oil, Port Arthur, Texas), secretary; Miss Helen Little (Humble, Oklahoma City), second vice president; Miss Nell Hagaman (Shell, New York City, first vice president; and Miss Paula Mace (Craig & Craig, Mt. Vernon, Ill.) president.

Desk & Derrick Marks 10th Year

One hundred sixty-four oil women made a sentimental journey to Houston in September to the annual ADDC convention. They had been there nine years before when Desk and Derrick had its first convention. Some 1050 women were registered for the meeting out of about 7000 members.

The Association of Desk and Derrick Clubs of North America is made up of oil women in USA and Canada. There are 115 clubs and this year saw the first Hawaiian delegate at the convention. Now under discussion is the idea of making the organization international.

Founded by Mrs. Inez Autey Schaeffer, a Humble employee, in New Orleans in 1959, the purpose of the association is to educate women working in petroleum and allied industries to "enlarge their scope of service." This is generally interpreted as meaning to improve job performance and to become a better representative of the industry in public relations.

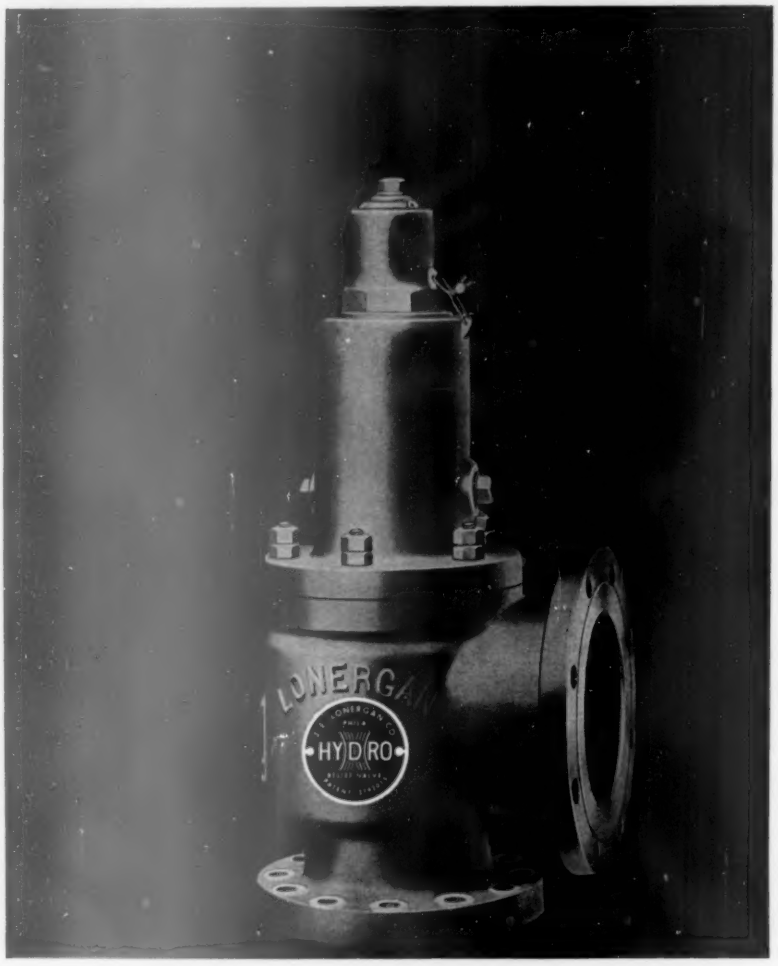
As Miss Gladys Watford, 1960 president, said in her keynote speech, "More than 1000 programs are presented each year to 7000 members. In the past two years 8000 members attended 325 field trips."

Programs are lectures such as those given at convention. This year E. Clyde McGraw, president, Transcontinental Gas Pipe Line, spoke on "The Natural Growth of Natural Gas" and William Naden, executive vice president of Humble, on "Oil and Gas People — Goodwill Ambassadors." Field trips are visits to operational centers — a well being drilled, a refinery, compressor station, research laboratory, computer center, equipment factory, etc.

With the help of petroleum and allied industry management, members obtain a basic course in a complex business. The first 10 years have provided experience for evaluation of the plan and at this date it would be hard to find a company or an individual employer who does not approve of the Desk and Derrick program. ■

All ADDC presidents attended the 10th anniversary of the Association. In order of their service, they are: Seated, Mrs. Lee Wilson Hoover, Alvin H. Howard, New Orleans; Miss Margaret Neff, Dixie Geological Service, Jackson, Miss.; Mrs. Irene Stimson Cox, Panhandle Producing, San Antonio; Mrs. Sybil Sureck, Union Oil of Oklahoma, Oklahoma City; Mrs. Edna Hurry, Jersey Standard, New York City; standing, Miss Irma Cline, Osborn & Thompson, Midland, Texas; Miss Maxine Hacke, Warren Petroleum, Tulsa; Miss Ellen Vaughan, Humble, Shreveport; Miss Gladys Watford, Ralph A. Johnson, Houston; Mrs. Bettie Conley, 1961 president, and Miss Mace, president-elect.

QUIET!



New Lonergan liquid relief valve doesn't chatter; eliminates product waste; reduces maintenance

Ever hear a relief valve chatter? They all do! They shout their faults to the world, while beating themselves to death. When you can hear one, you know product is being wasted; maintenance costs are increasing; employees are growing annoyed; and perhaps dangerous, flammable liquids are running loose.

Now you can install a Lonergan Hydro-Valve guaranteed not to chatter, hammer, or drum, *yet still deliver full rated capacity !* Gone is the need to install an oversized valve or a high-priced, heavyweight regulator valve to eliminate chatter on by-pass and emergency relief applications.

The Lonergan Hydro-Valve does not contain any capacity-reducing gimmicks or gadgets to eliminate chatter. Instead, it is designed to be completely quiet under all operating conditions. It proves itself so on hundreds of applications every day.

Bellows models of the Lonergan Hydro-Valve are also available for corrosive applications. The elimination of chatter and its associated bellows flexing action, greatly extends bellows life and virtually ends the need for expensive bellows replacement. *Full details are in a Hydro-Valve bulletin. Write for a copy today !*

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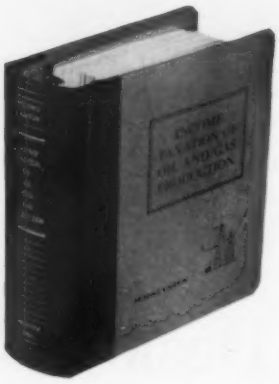
New Authoritative Guide INCOME TAXATION OF OIL AND GAS PRODUCTION



Thanks to this long-needed guide, it is now possible to predict the tax consequences of your oil and gas operations. Here, in one convenient source, you can quickly locate the answer to practically any question that may come up. For example . . .

In what three ways can grantor and grantee reduce the tax burden of the lease bonus for each other?

How can you realize a capital gain on the sale of an oil payment?

How can you choose to expense or capitalize delay rentals so as to enjoy special tax benefits?

What 10 provisions of the Tax Code apply to sharing arrangements?

What six principles have the courts established as governing losses from oil and gas interests?

It would be hard to think of any question, however uncommon, that is not answered in INCOME TAXATION OF OIL AND GAS PRODUCTION. This volume is the result of a mammoth research project undertaken two years ago by Clark W. Breeding and A. Gordon Burton — two noted authorities who are partners in the firm of Peat, Marwick, Mitchell & Co.

Clip and mail this convenient order form TODAY for your copy of INCOME TAXATION OF OIL AND GAS PRODUCTION — Prentice-Hall's superb new loose-leaf, tab-indexed volume. This guide to all current tax regulations, that will pay dividends for years to come, is yours for only $25 per copy.

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Safety Is What You Make It

Perhaps you may remember Mark Twain's classic comment about the business of growing up. "When I was a boy of 14," he wrote, "my father was so ignorant I could hardly stand to have the old man around; but when I got to be 21, I was astonished at how much the old man learned in seven years."

Applying that piece of philosophy to the subject of safety, everyone will agree that too many of us pay too little attention to the advice given us on how to work safely. Then, later, when an injury occurs, we wonder if we shouldn't have heeded that good advice more carefully.

The same sort of thing has marked the whole history of safety education. It has been true in industry generally. There was a time when putting on a pair of goggles, a safety hat, or replacing the old soft-toed shoes with a pair of safety shoes was considered by many as "sissy stuff."

Certainly nobody wanted to get hurt or hurt his fellow employee, but warehousemen, maintenance men, operators, yardmen, and those who drove automotive equipment, thought they knew their jobs and considered themselves as individualists who knew how to take care of themselves without a lot of protective gear and constant warnings.

However, little by little, the "Old Man," in the form of safety education, has been found to make a lot of sense. He may repeat himself often, and some of us get tired of listening, but we know he's right. If we don't listen, we are headed for trouble sooner or later.

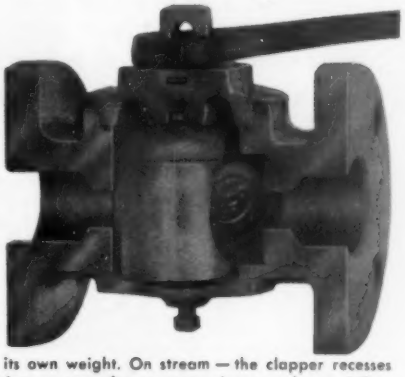
Thorough knowledge of safe practices by a person is a little like good manners. He doesn't have to worry too much about them when he needs them most. Similarly, if safety has become a genuine habit, it comes naturally and leaves a man free to concentrate on the things he does on or off the job.

His attention is not unduly divided by worrying about whether his methods are safe. He knows they are. He has been

FRANK WHEATLEY'S PLUGAROO!

OPEN

IT'S A CHECK VALVE



The clapper, hinged on a 20° angle, seals with its own weight. On stream — the clapper recesses into the valve body . . . presenting a full opening passage for scraper, pigs or spheres. When used as a check valve only, the "plug feature" provides a fast and convenient emergency shut-off or method of controlling flow. The PLUGAROO'S applications include gathering lines . . . transmission lines . . . LPG lines . . . product lines . . . meter runs. Anywhere there's piping . . . you can use a PLUGAROO! Available in sizes 1"-24"; full or regular opening; steel, semi-steel, alum. bronze, stainless steel; ASA 150 — ASA 2500; Teflon, Viton A, or Synthetic Rubber Seals; Standard API-ASA end connections.

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A quarter turn converts FRANK WHEATLEY'S PLUGAROO from a check valve to a non-lubricated plug valve! As the plug turns, it forms a cam action against the clapper . . . sealing it bubble-tight against the seat. From sizes 8" up . . . the PLUGAROO is equipped with weather-proof enclosed gears. Frank Wheatley's PLUGAROO requires no lubrication . . . you save 50% of the initial cost . . . plus untold hours in maintenance and expense of costly lubricants. Example price: Series 15-2" screwed ends . . . $10.39. Why buy 2 when 1 will do! As evidence of its growing acceptance . . . there are over 40,000 PLUGAROOS in use! Let us figure your savings on your next valve installation.

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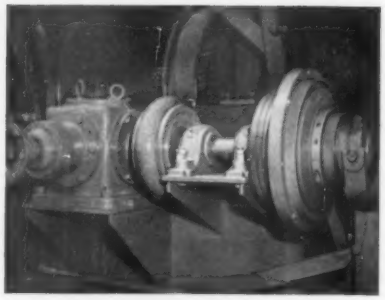
They are noted for their ruggedness. They are built to outlast the demands of the jobs on which they are used. And they carry their loads—radial and thrust, or any combination of the two—with minimum attention.

Dodge takes no chances with the fine precision built into these pillow blocks. They are painstakingly assembled, expertly adjusted, pre-lubricated and SEALED at the factory. You slip them onto your shaft in mint condition—and they stay that way!

There are 5 types of Dodge Pillow Blocks with Timken Bearings—Type E, Double Interlock, Type C (all with shaft sizes from 1-7/16″ to 4-15/16″, and down to 1-3/16″ in Type E), Special Duty with shaft sizes to 12″ and All-Steel—2-15/16″ to 10″. Available from your Dodge Distributor's stock. Call him, or write us for technical bulletin.

Dodge Manufacturing Corporation, 7900 Union St., Mishawaka, Ind.

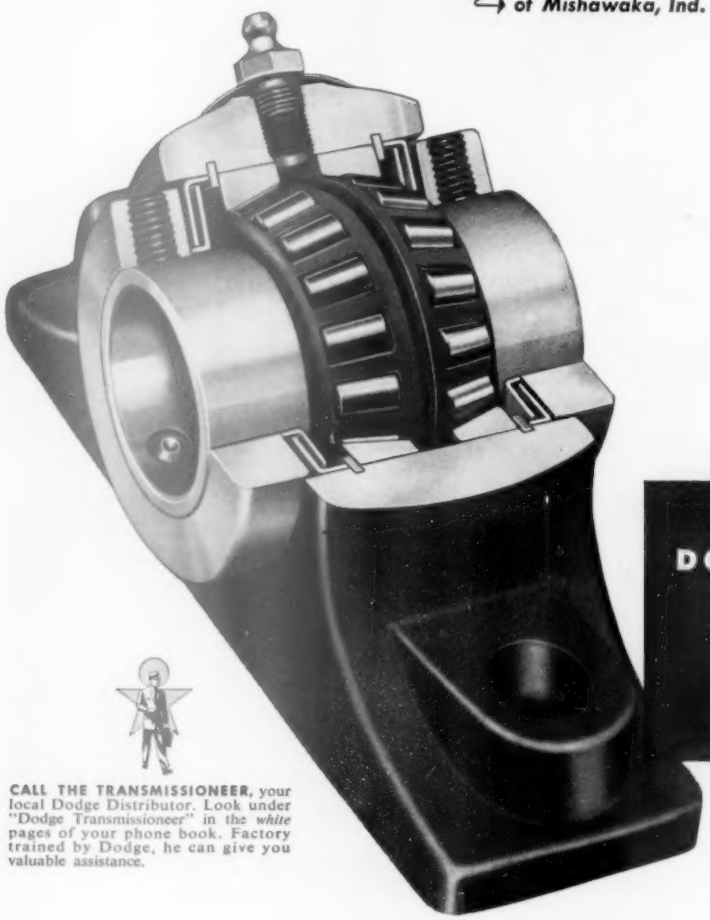
The Products with the Pluses... **DODGE** *of Mishawaka, Ind.*



Dodge Type E Pillow Blocks with Timken Bearings used for the drive hook-up of a rotary percussion drill.

Dodge Type C Pillow Block with Timken Bearings in cement plant — one of 4 in use on elevators since 1930.

Dodge Special Duty Pillow Blocks with Timken Bearings used on a skip hoist bull wheel for a blast furnace.



DODGE PILLOW BLOCKS with TIMKEN BEARINGS

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Look under "Dodge Transmissioneer" in the *white* pages of your phone book. Factory trained by Dodge, he can give you valuable assistance.

Special report to users of Caterpillar D7, D8 and D9 Tractors:

CAT CATERPILLAR

Parts you can trust
...cost less per hour

New Piston and Ring Combination Cuts Oil Consumption 33-50% ...Lasts Hundreds of Hours Longer!

What makes it so different? Look at the two Caterpillar-made pistons. Notice in the new design that *both* compression rings are now deeply seated in grooved cast iron (indicated in yellow) instead of only the top ring. Since cast iron is able to resist groove "pound out," both compression rings are held firmly *longer* in the correct position for maximum ring-to-liner sealing. Compression loss and blow-by *behind* rings and around grooves is delayed hundreds of hours, too.

The new intermediate compression ring is a "twist" ring, so-called because it changes position in the groove during the power stroke. It actually "twists" so its face has *greater sealing area* at the liner than regular rings—reducing the number of compression rings normally required. At the same time, it thins the film of oil left by the regular oil control ring. This leaves less oil to burn away which contributes to the new piston's better oil control and longer ring life.

All rings now have a new look, too . . . *each and every* face is thickly chrome plated against wear. They are also "bright lapped" to such brilliance that any flaws can be easily seen and the faulty ring rejected. Such quality control assures almost perfect seating right from the start, eliminating break-in blow-by, slobbering and scuffing.

Cost? Pistons with the *extra* cast iron bands cost *slightly more*, but ring sets are less! Once you change over, your tractor maintains its power longer, your fuel and oil bills go down, and your next set of replacement rings will be less. Your Caterpillar Dealer has them in stock now.

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

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trained and trained himself that way.

In addition to everything else, the knowledge that one is working safely, and that those nearby are doing the same, makes for a sense of rightness that contributes to safety and good morale.

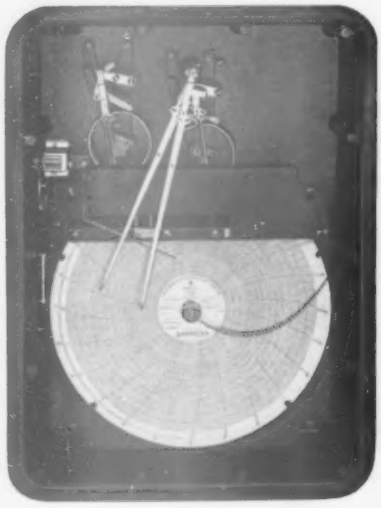
On the other hand, an employee's awareness that injuries are occurring frequently to other employees, and his knowledge that unsafe conditions exist on every side, will do much to create accident-producing situations and damage his morale.

We would all do well to listen carefully to what "Old Man Safety" has to tell us. Briefly, it is this: The only way to lessen the danger of accidental injury is to make safety a real important part of everything we do.

EDITOR'S NOTE: Written by Quincy V. Tuma, this is reprinted from *Texaco Safety Digest.*

■

INTEGRATING ORIFICE METERS



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Single, double and duplex-integrating models available in a wide range of manometer types and working pressures. Dust-proof, die-cast aluminum cases... Gasclok and electric instrument chart drives. Also supplied with American Telecounter for remote readings.

See Bulletin 401 for details.

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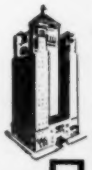

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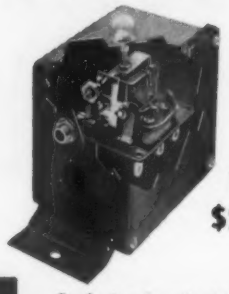

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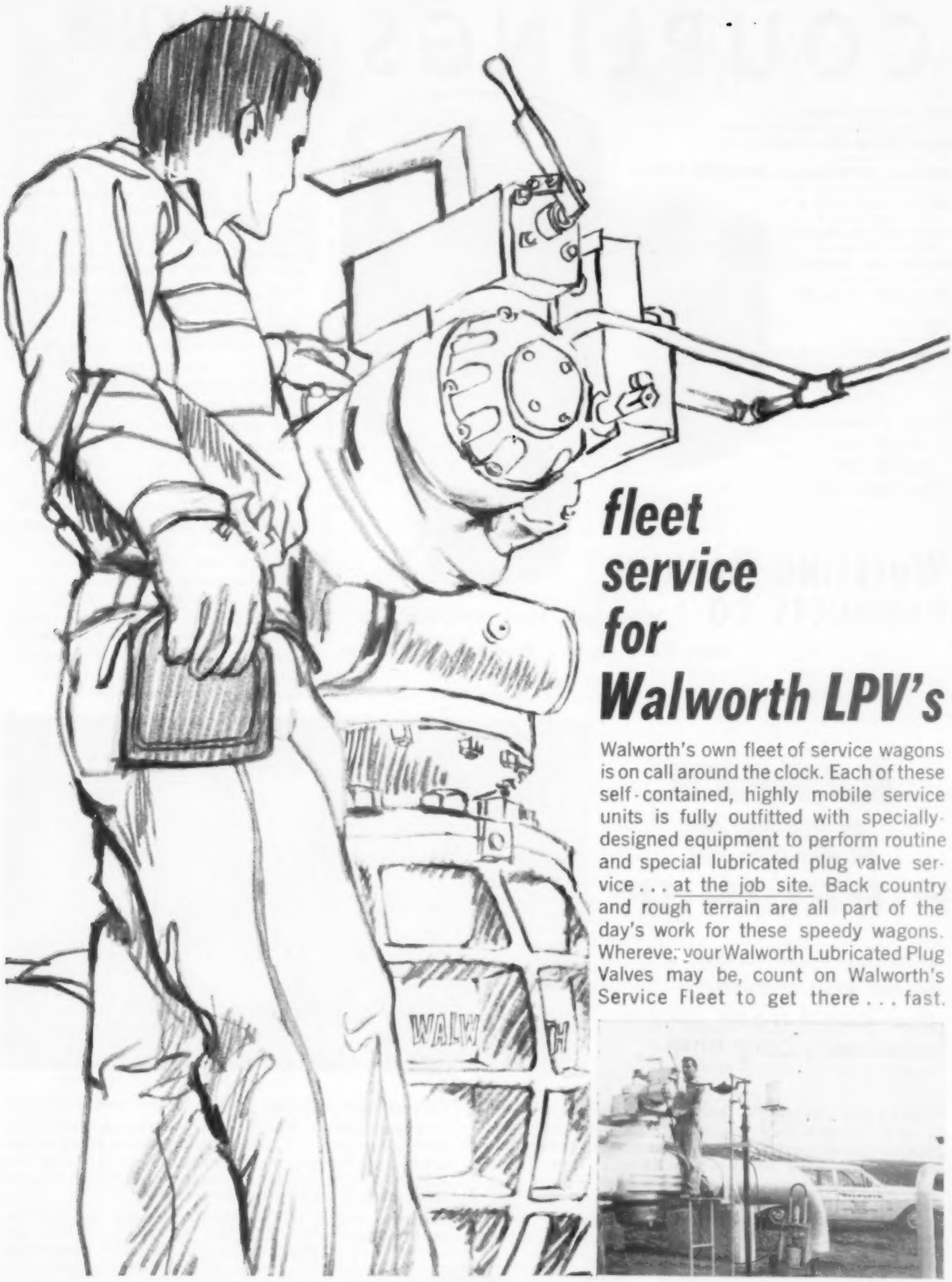

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BOOKS

Engineering College Research Review 1961. Edited by Paul T. Bryant and John F. Penn. Write American Society for Engineering Education, University of Illinois, Urbana, Ill. Pages, 476. Price, $4.

This is the tenth edition of the biennial review. It covers 11,000 research projects in 121 engineering colleges throughout the U.S. In 1961 more than 180 million dollars have been spent on these projects. This is the highest ever recorded in the seventeen years of ECRC surveys. There is a complete index of research projects, titles, number of persons engaged in each institution.

Tested Techniques for Developing and Selling Your Ideas, by Robert Rawlins, published by Executive Development Press, Littleton, N. H. Pages, 32. Price $1.50.

"You haven't an idea until you can express—on paper—what you have in mind in a short paragraph or perhaps even in a single sentence," says the author. Rawlins, who wrote "Time Out for Mental Digestion", in his newest book outlines tested and proved techniques of successful executives in some of the nation's largest businesses and industries.

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keep you moving . . .
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See your nearby UNIT distributor soon and find out more about the ¾-yd. Model 1220 PIPELINER. It's available with 24" and 30" width deep grouser shoes, or with 36" shoes, semi-grouser type.

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John: "My wife has the worst habit of staying up until one and two o'clock in the morning, and I can't break her of it."

Joe: "What is she doing all that time?"

John: "Waiting for me to come home."

"How did you find the ladies at the dance?"

"Oh, I just opened the door marked 'Ladies' and sure enough, there they were."

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An English lady, self-appointed supervisor of village morals, accused a workman of having reverted to drink because "with her own eyes" she had seen his wheelbarrow standing outside a tavern.

The accused made no defense, but that evening he put his wheelbarrow outside her house and left it there all night.

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The judge listened intently to a case against a man who was charged by his wife with non-support. After all the evidence was in, the judge told the defendant, "You haven't taken proper care of this good woman and I'm going to give her $25 a month."

The defendant beamed with pleasure. "That's mighty nice of you, your honor," he said, "and I'll giv'er a dollar or two from time to time myself."

"I know we are traveling faster than sound," the passenger said, "because the stewardess slapped me before I got a word out of my mouth."

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Why can't life's problems hit us when we're 18 and know everything.

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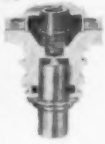

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Meetings

Nov. 13-15 — API 41st annual, Conrad Hilton Hotel, Chicago, Illinois.

Nov. 15 — API Board of Directors meeting, Conrad Hilton Hotel, Chicago.

Nov. 16 — National Industrial Conference Board, general session, Sheraton-Cadillac Hotel, Detroit, Michigan.

Nov. 16 — Illinois Oil & Gas Assn. annual, Mount Vernon, Ill.

Nov. 17 — Natural Gasoline Assn. of America, Panhandle Plains regional, Herring Hotel, Amarillo, Texas.

Nov. 26-Dec. 1 — ASME, winter annual, Statler-Hilton Hotel, New York City.

Nov. 27-Dec. 1 — International Chemical Exposition, 28th exposition of chemical industries, New York Coliseum, New York City.

Nov. 27-Dec. 1 — National Assn. of Corrosion Engineers, Southeast region conf. and Florida general conf. short course, Key Biscayne Hotel, Miami, Fla.

Nov. 28-29 — Western Petroleum Refiners Assn., refiners computer conf., Tulsa, Oklahoma.

Nov. 29-30 — National Assn. of Corrosion Engineers, board of directors meeting, Key Biscayne Hotel, Miami.

Dec. 1 – Utah Petroleum Council, annual, Prudential Building, Salt Lake City, Utah.

Dec. 3-6 — American Institute of Chemical Engineers, annual, New Yorker Hotel, New York City.

Dec. 4 — The Asphalt Institute, Technical Coordinating Committee, Shoreham Hotel, Washington, D. C.

Dec. 4 — AIME, Society of Petroleum Engineers, Arizona section, annual, Pioneer Hotel, Tucson, Ariz.

Dec. 4-6—Interstate Oil Compact Commission, annual meeting, Denver Hilton Hotel, Denver, Colo.

Dec. 5 — The Asphalt Institute, executive committee meeting, Shoreham Hotel, Washington, D. C.

Dec. 5-6—Western Petroleum Refiners Assn., refiners computer conf., Hotel Tulsa, Tulsa, Okla.

Dec. 6-7 — The Asphalt Institute, board of directors annual, The Asphalt Institute, Washington, D. C.

Dec. 14 — National Industrial Conference Board, board members, Waldorf-Astoria Hotel, New York City.

1962

Jan. 7-10 — Pipe Line Contractors Assn., annual convention, Boca Raton Hotel, Boca Raton, Fla.

Jan. 8-12 — Society of Automotive Engineers, annual, Cobo Hall, Detroit, Mich.

Jan. 17 — Mississippi Petroleum committee meeting, Heidelberg Hotel, Jackson, Miss.

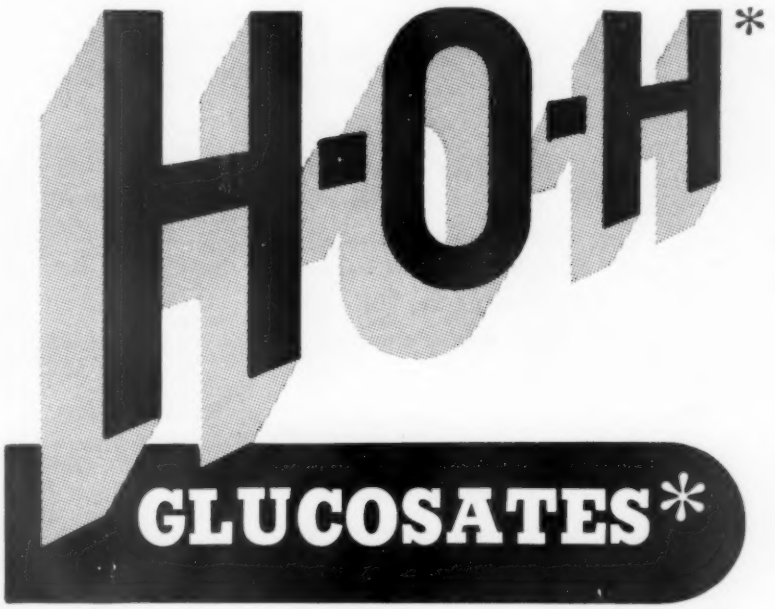
Jan. 17-19 — National Assn. of Corrosion Engineers, Canadian region eastern division conf., King Edward Hotel, Toronto, Ont.

Jan. 19 — Natural Gas Processors Assn., Gulf Coast regional, Robert Driscoll Hotel, Corpus Christi, Tex.

Jan. 21-23 — Kansas Petroleum Industries committee, 10th annual convention, Broadview Hotel, Wichita, Kans.

Jan. 21-26 – ASTM committee, D-2 meeting, Chase Park-Plaza Hotels, St. Louis, Mo.

Feb. 4-7 — American Institute of Chemical Engineers, national-meeting, Statler Hotel, Los Angeles, Calif.



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World Production of Crude Petroleum by Countries[1]

(Thousand barrels[2])

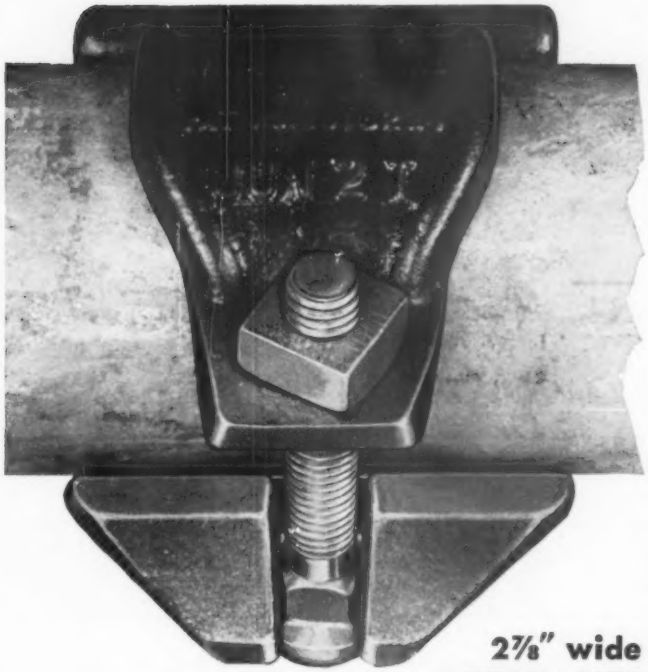
Country	1956	1957	1958	1959	1960
North America:					
Canada	171,981	181,848	165,496	184,778	191,842
Cuba[4]	543	395	344	192	[5]108
Mexico	90,660	88,266	93,533	96,393	99,049
Trinidad	28,929	34,064	37,355	40,919	42,357
United States	2,617,283	2,616,901	2,449,016	2,574,590	2,574,933
Total	2,909,396	2,921,474	2,745,744	2,896,872	2,908,289
South America:					
Argentina	31,013	33,952	35,829	44,710	64,232
Bolivia	3,196	3,575	3,435	3,170	3,574
Brazil	4,059	10,106	18,919	23,590	29,613
Chile	3,542	4,337	5,568	6,428	7,231
Colombia	44,968	46,782	46,901	53,576	55,666
Ecuador	3,420	3,191	3,108	2,759	2,730
Peru	18,383	19,222	18,732	17,733	19,255
Venezuela	899,212	1,014,457	950,796	1,011,452	1,041,708
Total	1,007,793	1,135,622	1,083,288	1,163,418	1,224,009
Europe:					
Albania	1,868	3,268	2,690	3,504	3,650
Austria	23,622	21,955	19,548	16,946	16,874
Bulgaria	1,691	2,095	1,632	1,402	1,460
Czechoslovakia	732	732	950	803	730
France	9,100	10,157	9,983	11,594	14,229
Germany, West	25,408	28,698	32,119	36,981	40,076
Hungary	9,172	5,150	6,325	7,665	8,760
Italy	4,209	8,593	10,531	11,551	13,545
Netherlands	7,652	10,623	11,306	12,367	13,378
Poland	1,363	1,341	1,298	1,277	1,460
Rumania	81,390	83,327	84,490	83,492	87,600
USSR[6]	611,740	717,926	826,477	945,340	1,080,400
United Kingdom	489	606	591	621	649
Yugoslavia	2,076	2,797	3,267	4,188	6,671
Total[6]	780,512	897,268	1,011,207	1,137,731	1,289,482
Asia:					
Bahrein	11,015	11,691	14,823	16,473	16,500
Burma	1,837	2,958	3,454	3,967	4,078
China[5]	4,700	5,000	6,000	15,330	26,280
India	2,876	3,241	3,258	3,377	3,370
Indonesia	93,820	114,151	118,711	139,038	152,988
Iran	197,148	263,134	301,361	344,800	390,754
Iraq	232,307	163,498	266,125	311,193	353,833
Israel	146	394	642	925	930
Japan	2,169	2,243	2,563	2,852	3,678
Kuwait	399,874	416,045	509,654	504,855	594,278
Kuwait-Neutral Zone	11,684	23,259	29,469	42,438	49,829
Pakistan	2,118	2,200	2,272	2,333	2,636
Qatar	45,300	50,798	63,412	61,431	63,088
Sarawak and Brunei	42,983	41,821	39,551	40,072	34,005
Saudi Arabia	360,923	362,121	370,486	399,821	456,453
Taiwan (Formosa)	21	17	15	13	14
Turkey	2,213	2,159	2,379	2,700	2,624
Total[6]	1,411,134	1,464,730	1,734,175	1,891,618	2,155,338
Africa:					
Algeria	253	101	73,315	[7]10,625	[7]67,408
Angola	52	71	358	361	477
Congo, Republic of (formerly French)	—	—	—	—	365
Gabon, Republic of	—	1,207	3,550	5,295	5,626
Morocco: Southern zone	734	566	560	712	695
Nigeria	—	—	1,970	4,067	6,552
United Arab Republic (Egypt Region)	12,185	16,157	21,960	21,303	23,968
Total	13,224	18,102	31,713	42,363	105,091
Oceania:					
Netherlands New Guinea	2,610	2,279	1,850	1,656	1,538
New Zealand	7	6	5	5	[5]5
Total	2,617	2,285	1,855	1,661	1,543
World total	6,124,676	6,439,481	6,607,982	7,133,663	7,683,752

[1]This table incorporates some revisions.
[2]42-gallon barrels.
[3]Preliminary figures.
[4]Natural naphtha and gas oil.
[5]Estimate.
[6]USSR in Asia (also Sakhalin) included with USSR in Europe.
[7]Including Sahara.

Compiled by Pearl J. Thompson, Division of Foreign Activities, U. S. Department of Interior.

For speediest repair of corrosion leaks in pipe

JUNIOR EMERGENCY PIPE CLAMP



2⅞" wide
ACTUAL SIZE

Speediest application — slotted lug permits the single plated bolt to slide instantly into place.

A companion to the old reliable Emergency Pipe Clamp that has served industry for a half century, the JUNIOR, a single bolt clamp, is 2⅞" wide. Undersells most band-type clamps.

Made of malleable iron, ruggedly proportioned, with full length hinge along one side. Formed to exact pipe size. The recessed pressure-equalizing gasket, entire width of clamp, is "bonded" in place with plastic laminate adhesive. A lasting installation. Write for folder.

Lug on gasket half is slotted

M. B. SKINNER CO., South Bend, Ind.

SKINNER-SEAL JUNIOR EMERGENCY PIPE CLAMP

The Bigger Egg

In a tiny village southeast of Djakarta, Java, capital of Indonesia, two hens' eggs recently fascinated a group of local farmers who had come to town to look at them. One egg was nearly twice as large as the other. What made the egg bigger? An oil company.

When Caltex went into Central Sumatra Indonesian poultry farmers sold small eggs and even these were scarce. The company began a program to improve local egg production. Brood eggs and medicines were brought in to foster better flocks; hens were put on a scientifically balanced diet. Now the birds eat better and so do the Caltex crews. All Indonesians stand to benefit from better nourishment as the new knowledge of poultry farming spreads.

The most obvious benefit to an oil-producing country is the revenue collected from royalties, fees, taxes, and other payments. In some countries these represent most of the total national revenue, and they allow the governments to do things for their citizens that never could have been accomplished otherwise.

Also, what the oil companies have done on their own has vastly improved conditions for everyone. Evidence of this is abundant, and examples are easily found. Venezuela makes an almost-perfect case in point.

Old Venezuelan hands will tell you that when they first went into the country there were virtually no roads connecting the major cities with the countryside. Look at a road map of Venezuela today, and you will see that it is criss-crossed with good roads. A great many of them were built by oil companies, frequently as service roads leading to drilling operations, refineries, or alongside pipelines.

The same is true of airports and harbors. Venezuela had no airport of significance 30 years ago; today it has a dozen-odd, many of them originally set up by oil companies and later turned over to the government.

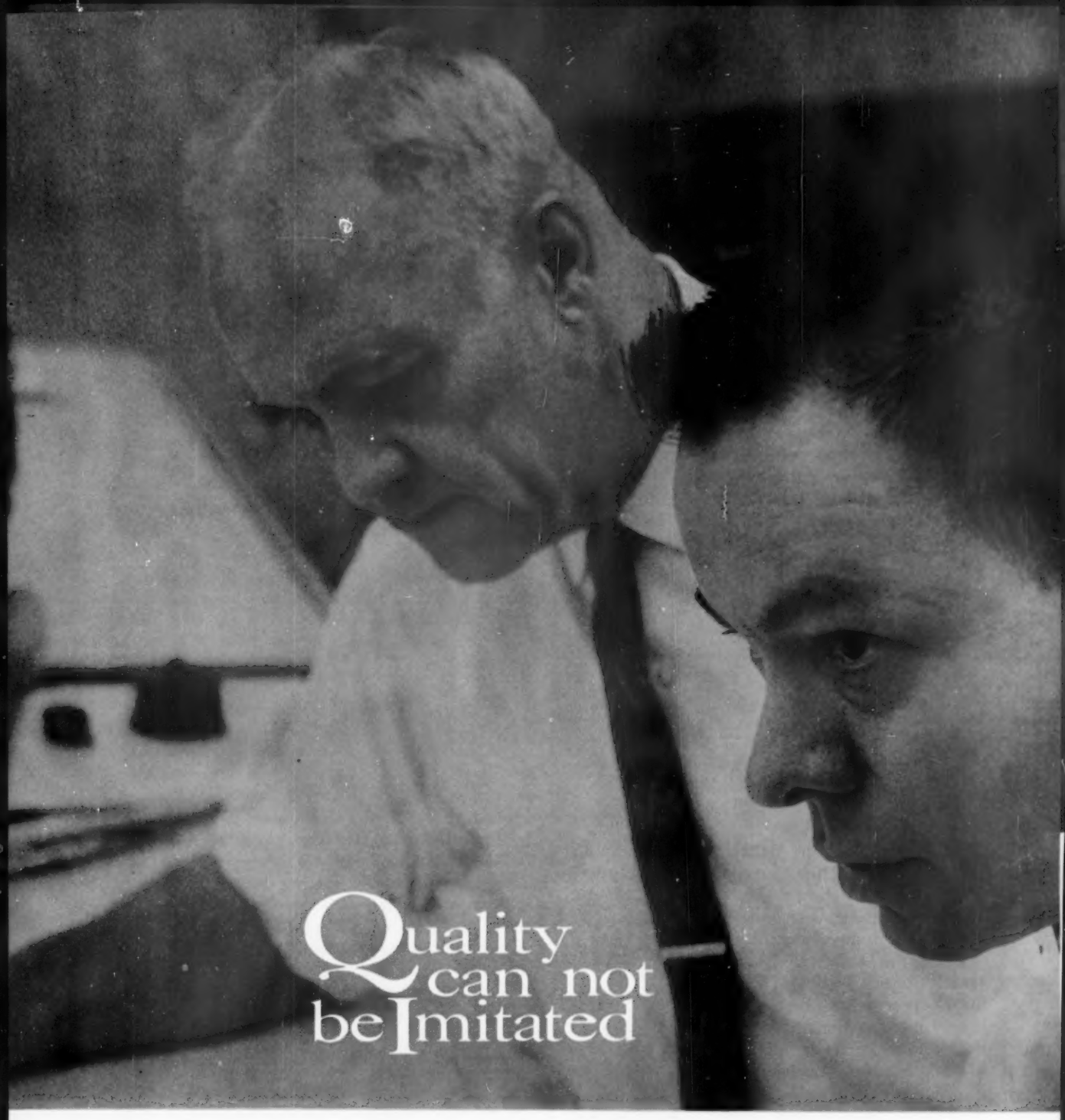
When the first oilmen moved into Venezuela, there was virtually no middle class as we know it. One was either extremely rich or desperately poor. Now there is a middle class, and it is growing as the number of Venezuelans who have established small businesses (often as not to supply the oil companies) has grown.

Roads, airports, harbors, are the big things in a country's economic development. There are many smaller ones that don't turn up on economists' charts but still mean a great deal to a nation. In Venezuela, for instance, poor sanitation and lack of medical facilities in outlying areas is a chronic problem. Serums and vaccines have been donated; hospitals, open to workers and their families, have been established.

In education, too, oil has played a big part. All through the oil country, company-built schools have been set up for employees and their families. Apprentice-training courses that teach skills like machining and welding have been conducted for years.

In Colombia oil has made a notable difference in the economy. For one thing, revenues from oil account for nearly 30% of the nation's revenue, and that is a considerable slice: in dollars it comes to about $100,000,000 a year.

Vast areas of the Colombian jungle have been



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Salt Lake City, Utah — G. M. Wallace & Co., Continental Bank Bldg.
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opened by oilmen, to make farming and homesteading possible where it had not been before. Texaco operates a tree nursery in Colombia, and sells seedlings to farmers at low cost as a way of encouraging land conservation through a continuing rebuilding of timber land depleted by lumbering. The company has a business interest in the forestation project; it needs lumber for housing, rig timbers, bridge building, and other construction work.

Colombians Can Buy Homes

Oil companies have housing plans under which workers can borrow money to build homes and pay off mortgages that are underwritten by their employers. A few years ago this would have been unthinkable: most Colombians had never heard of mortgage payments, never had hoped to own their own homes.

Fruit-farming and cattle-raising both have become substantial businesses because of the great volume of fruit and beef that oil companies buy locally. Right now petroleum is Colombia's largest employer.

On the other side of the world, in Bahrain, an island sheikdom in the Persian Gulf, no one questions the effect oil has had on the people. Oil is that country's biggest single industry. Bahrain Petroleum buys a large part of its paint, tires, drill pipe, and almost everything else it needs from more than 200 local merchants. Its purchases approach $3,500,000 each year, and in many cases its needs have put a local citizen in business.

Bapco has been in Bahrain more than 25 years, and during that time it has made great contributions to the country's health. Perhaps its most dramatic contribution was its cooperation with the government in a fight to stamp out malaria. Today the debilitating disease is practically eradicated.

For many years, the company has held training courses for its employees that teach subjects like welding, driving, and pipefitting. In 1947, it made academic training available, and today it offers Bahrain's such advanced courses as chemistry, physics, and higher mathematics. Hundreds of youngsters have been given apprentice training. They are put on the company's payroll while they learn, and are allowed to pick the technical specialty that most interests them. The apprenticeships last four years, but they may leave at any time and are not obligated to remain with the company if they graduate.

In the first five-and-a-half years of this program, more than 600 employees were taught and more than 85% of them went on to permanent jobs with Bapco. When a particularly bright child is spotted he is sent to England for higher-level education.

Oilmen have been working in Trinidad for more than 50 years, and there is little doubt that oil is largely responsible for the fact that Trinidadians enjoy the highest per capita income of any group of people in the West Indies.

In Indonesia, remember, there was a problem with eggs. In Trinidad milk was the problem. Veterinarians were called down from the States, grass seed was imported to start better pastures. Visits to American dairies were made by Trinidad's management people. The ultimate aim of the program is to provide the company's workers and their families with all the milk they want at reasonable prices.

One of the most sensational oil finds in the industry's history was made in Saudi Arabia, in 1938. Today thousands of Saudi Arabia's citizens have become skilled workers living a comfortable life their grandparents never dreamed of.

The principal company in Saudi Arabia is Aramco, which at the end of last year had over 11,000 Saudi Arab employees, and about 76% held semiskilled, skilled, supervisory, or professional jobs.

Saudis to College

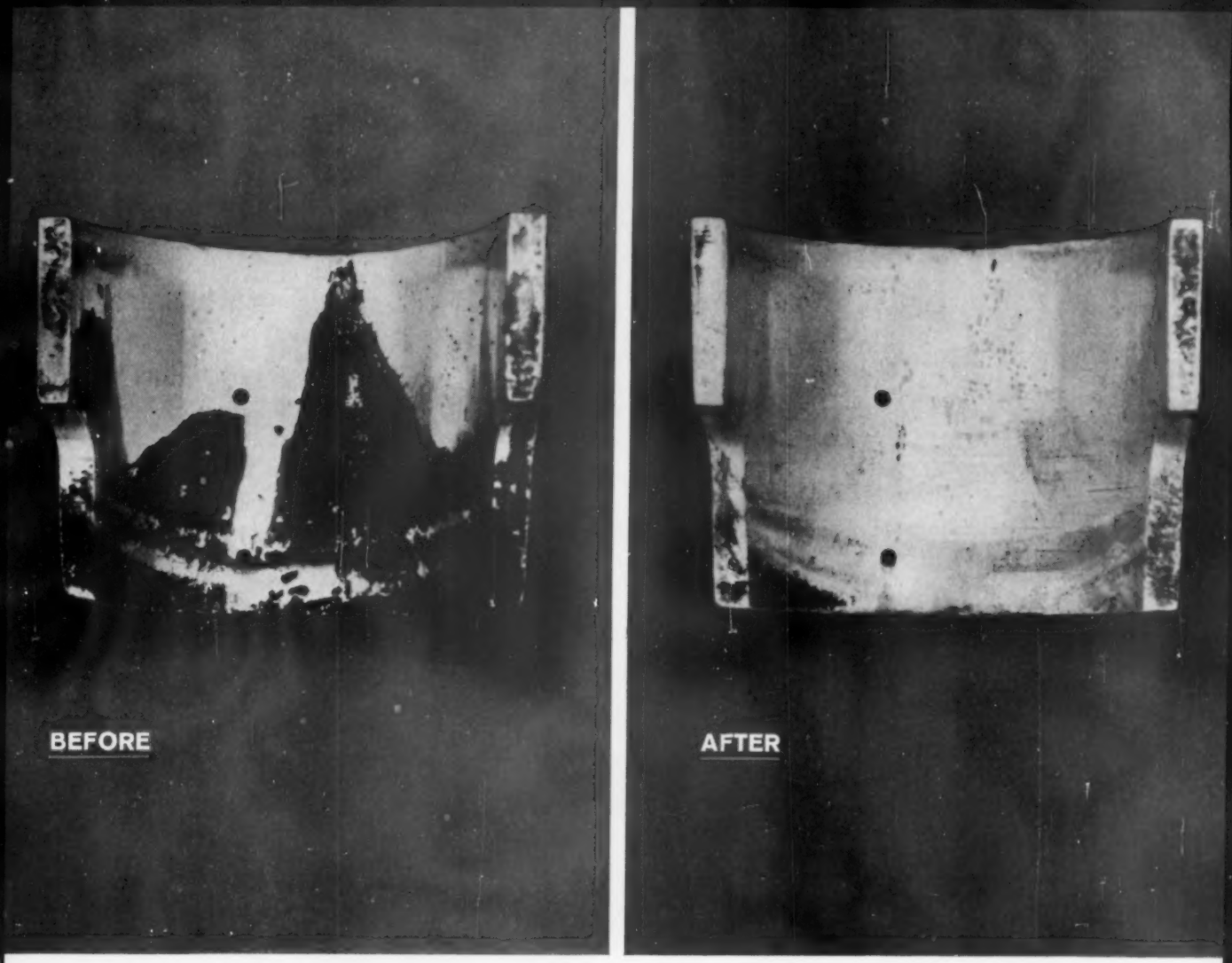
In the 1960-61 academic year, Aramco sent 29 Saudi Arab employees to colleges and universities outside the Kingdom for advanced specialized training. Enrollment of employees in classes during working hours at Aramco's industrial training centers averaged more than 4,500 each trimester during 1960.

Perhaps the most important contribution Aramco has made to the Saudi Arab lies in the field of public health. When oilmen first arrived, a dismaying percentage of the population suffered from trachoma—a serious disease of the eyes that can lead to blindness. The company promptly set up clinics to treat the infected Arabs, and today the incidence of trachoma is decidedly lower.

The list of foreign countries that have benefitted, or stand to, from American oil operations would fill a good-sized gazeteer. Sumatra has gained much more than grown-up eggs; Libya already feels the economic impact exploration work can make. All over the world, the American oil producer has been as much benefactor as businessman.

EDITOR'S NOTE: This is a condensed version of "Welcome Guest, Worldwide," published in The Texaco Star for Summer 1961. Manager of Publications, Ellis Prudden; Editor, Texaco Star, D. L. Tullsen.

■



Du Pont's multifunctional additive, DMA-4, cleans carburetors and keeps them clean

Carburetor detergency is a striking example of the performance values you can add to gasolines with Du Pont DMA-4.

The carburetor throat liner you see above illustrates how this additive cleans up power-robbing deposits.

On the left, the liner is coated with residue after exposure to an untreated premium gasoline, under severe test conditions. On the right is the same liner after only two hours additional operation under normal operating conditions using the same gasoline treated with DMA-4 at a concentration of 10 pounds per thousand barrels.

Results of other tests have demonstrated that six pounds of DMA-4 per 1,000 barrels of gasoline will prevent deposit accumulations even under the severe conditions utilized to develop the "before" build-up shown above.

The "clean – keep clean" detergency action of DMA-4 is, however, only one of the performance values offered by this Du Pont additive. DMA-4 also offers:

- **Anti-stalling properties.** DMA-4 sets up a protective film that makes throttle plates and other internal surfaces water repellent, thus preventing stalling due to ice formation on cool, damp days.
- **Rust prevention.** The protective film also protects metal surfaces (engine parts as well as pipelines and storage tanks) from corrosion.
- **Phosphorus credit.** DMA-4 contains phosphorus compounds of the type helpful in suppressing surface ignition and spark plug fouling caused by combustion chamber deposits. The concentration of other phosphorus additives can, therefore, be reduced proportionately to obtain minimum treating costs.

Descriptive Bulletin Available

A product bulletin describing DMA-4 is available. To obtain your copy, and to find out how DMA-4 may add new performance and sales values to your gasolines, contact your Du Pont Petroleum Chemicals Division representative. E. I. du Pont de Nemours & Co. (Inc.), Petroleum Chemicals Division, Wilmington 98, Delaware.

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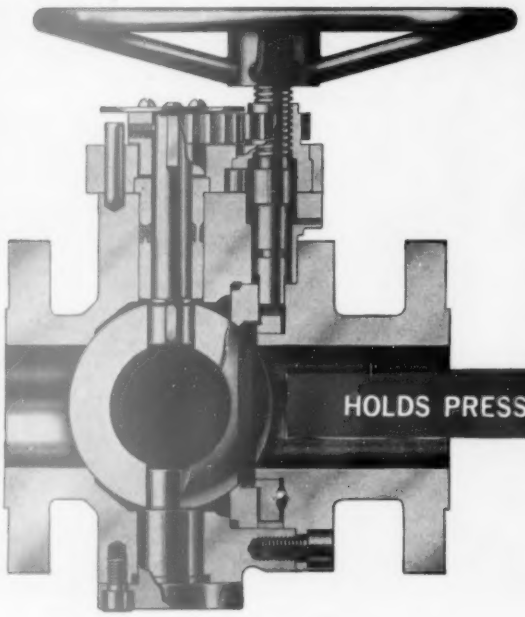

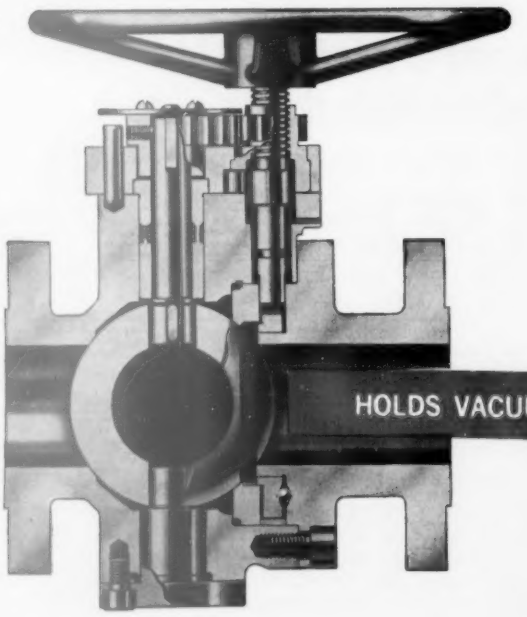

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BALL Type "K" PLUG

VALVES

Controlled sealing . . . a new concept in valve design . . . is the secret of Hydril's tight, bubble-proof shutoff. Hydril Ball-Plug Valves always seal positively against pressure from either direction—or against vacuum—because the fully confined packing ring is mechanically compressed between plug and seat when the valve is closed. This tightly compressed gasket type seal easily bridges clearances between parts as well as surface imperfections. Result: seal efficiency is unimpaired by prolonged hard usage, by rust or sediment.

Design of Hydril Type "K" Ball Plug Valves assures minimum maintenance costs. Non-lubricated, they employ no sealing lubricants. There's no sliding friction between plug and body to produce wear and abrasion.

The spherical plug is mounted on accurately positioned bearings, maintaining a minimal controlled clearance between plug and body. This contributes to easy, free-turning operation as well as to long service life.

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Hydril valves are available in a wide range of sizes and ratings. Worm-gear and motor-operated models can be supplied. Get the full story on Hydril Valves from your nearby representative . . . or write Hydril Company for free Catalog No. V-60.

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By adding a small amount of Unicor to your product—10-20 parts to a million—you prevent product contamination, profit-robbing corrosion; assure maintenance of full-flow capacity and output.

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Franks Explorer Has....

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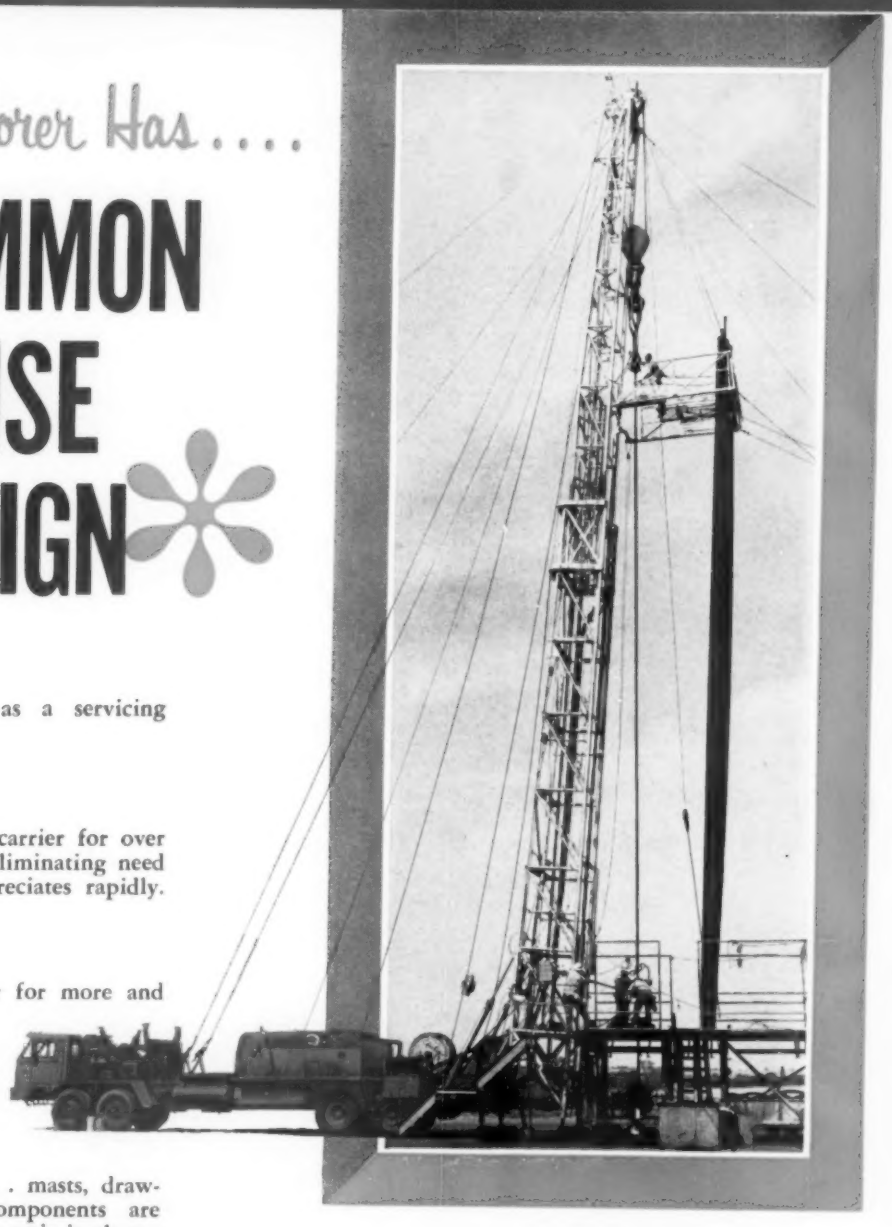

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Industrial horsepower for more and faster work.

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Greater flexibility . . . masts, drawworks and other components are interchangeable. Your unit is always up-to-date.

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Fluid Loss Control Helps Boost Fracture Area Efficiently

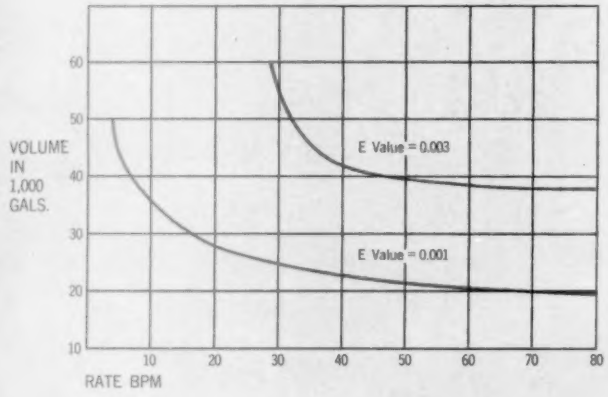
Inefficient fracturing fluids usually drain away without ever attaining the potential fracture area, or can require uneconomical volumes of fluid and horsepower to achieve it. Sandouts pose another threat when the fracturing fluid leaks off into the formation leaving propping agents behind to restrict fracture extension.

The culprit in these situations is uncontrolled *fluid loss*. Halliburton Fluid Loss Control Additives help arrest the loss of treating fluid to permeable formations by building a protective temporary barrier across the face of the fracture. When fluid loss is controlled, the main target for the fracturing fluid's work is the outer extremities of the enlarging fracture. These more efficient fluids driving under *continuous* pressure into these extremities are very important in attaining maximum fracture extension for greatest production.

Recommending the proper Fluid Loss Additive in the correct proportion is an important element of Halliburton's FRACPLAN Service — the new design for fracturing wells. Get acquainted with Halliburton Fluid Loss Additives like WAC-8, WAC-9, WLC-1, WLC-2, ALC-5, and FL-2. They could make the difference in the profitable stimulation of your well.

See your Halliburton man for the full FRACPLAN story — including all the benefits of Halliburton fluid loss control.

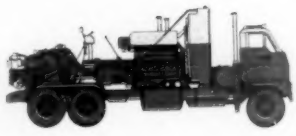
FRACTURE AREA – 100,000 SQUARE FEET
FRACTURE WIDTH – 0.24 INCHES



The more efficient fluid with an Efficiency Value of 0.001 will theoretically obtain the desired fracture area with an economical combination of volume and injection rate. These values, based on sound mathematics and experience, show that the less efficient fluid with an Efficiency Value of 0.003, would probably never attain the desired fracture area at most ordinarily used injection rates and volumes.

Watch your FRACPLAN at work
...ask about the FRACOMETER

FRACTURING SERVICES



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Things To Come

DEMAND ON UPSWING

Petroleum product demand will stage a comeback in 1962, predicts M. P. Murdock, vice president of the Ethyl Corp. Basing his predictions on anticipated better business and industrial activity in the year ahead, he sees a 3.2% increase in total product demand. Such demand for 1961 is expected to increase only 1.8% over 1960 levels. Specifically, the 1962 demand for all products is forecast at 10,168,000 bbl per day, compared to 9,849,000 bbl for 1961.

COMPUTERS READ LOGS

Analysis of electric well logs will be handled by digital computers. Preliminary studies made at the University of Illinois show that the computers can be programmed to distinguish between various formations on the basis of porosity. The complete story can be found in this issue.

TOWN-LOT DRILLING

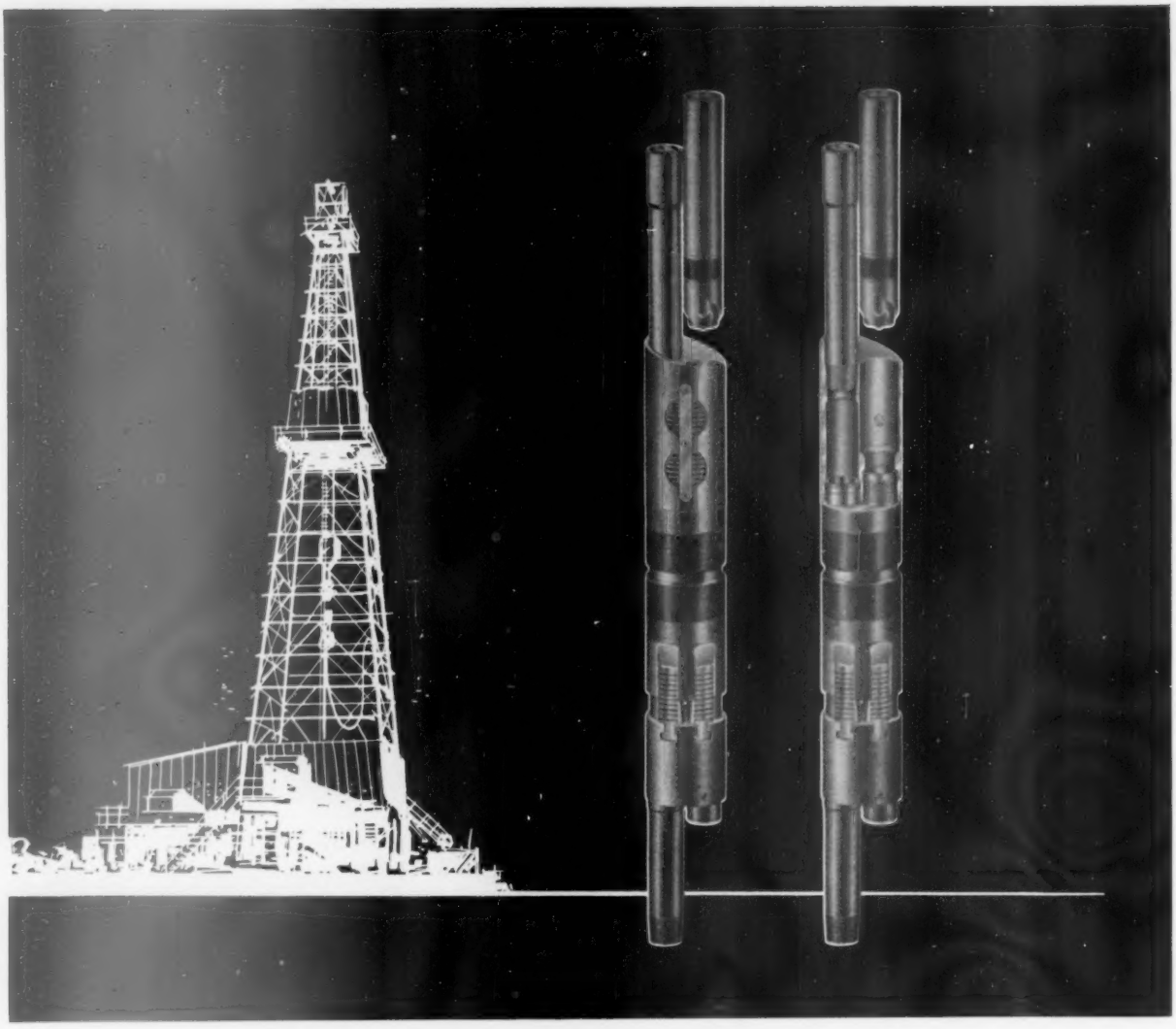
Drilling for oil or gas on small tracts which can not support the expense of drilling the well will soon end in Texas. By pegging allowable production strictly to acreage, the Texas Railroad Commission has removed the incentive for drilling these wells which must drain adjoining properties to pay out. The Commission's ruling was applied to the famous Normanna gas field, but is expected to be extended to all such cases.

DRILLING PEAKS HOLD

Record levels of drilling activity set in 1955-56 will remain unchallenged for several years, says Hughes Tool Co. in announcing further steps in its diversification. The lack of increased demand for rock bits and tool joints played a big part in the company's new plant designed for the rebuilding of machine tools and related equipment.

DRILL PIPE CODING

Standardization of coding or classification of drill pipe is now under serious consideration by the AAODC, working with the API on this project. It may take some time to work out a satisfactory and simplified system, but its purpose is to identify used drill pipe so any assigned grade will mean the same in all parts of the country. This will not alter inspection programs.



VERSATILE AND RETRIEVABLE
BROWN DSL-9 SERIES PACKERS

Brown Mechanically Set Dual String Packers—Types DSL-9-2 and DSL-9-2H—are versatile. They can be run on either the long or short tubing strings. They are set with weight from either the long string or both tubing strings. There is no danger of their setting before the bottom packer is landed, and buckling of tubing below the dual packer is prevented because packer slips take the weight. If excessive pressure is expected blow the packer, a hydraulic holddown on Type DSL-9-2H prevents unseating. If desired, both tubing strings can be detachable from the packer, permitting either string to be serviced independently.

For years, Brown has stressed retrievability of packers. Brown dual, triple, quadruple and quintuple retrievable packers have been set in thousands of wells with multiple parallel tubing strings – in fact, present multiple completion methods are made practicable by retrievable packers. Continuing this tradition, Brown Type DSL-9 Packers are readily retrievable.

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Here's the most complete, most efficient line of perforating services available to the oil industry – all designed with one objective – to get more oil, *best* possible production!

Choice of the type perforating process to be used depends on the nature of the formation to be penetrated and the method of well completion; whether in full size casing, thru-tubing or in slim holes.

At McCullough you'll find bullet and jet guns, in a variety of types and sizes, to handle every requirement – quickly, efficiently and profitably – your *best* bet for *best* production!

FOR PERFORATING IN CASING

McCULLOUGH BULLET GUNS – World's hardest shooting bullet guns. Best available perforating process in all formations except extra hard.

McCULLOUGH GLASS JET GUNS – Most versatile and efficient of all jet casing perforators. Deep penetrating, carrot-free, junk-free. Uses flexible, retrievable Steel Strip Carrier. Gets best results in hard formation.

McCULLOUGH TUBULAR CASING JET GUNS – Star Jet, DuPont, Dynajet and Super Dynajet charges are available in most areas to meet varying well conditions.

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McCULLOUGH SECTIONAL BULLET GUNS – Only small diameter bullet guns made. Sizes are 1⅜", 1¾" and 2¼" OD. Backed by a record of more than 20 years of fine performance.

McCULLOUGH MAC-JET GUNS – Finest and most advanced of all small diameter, expendable jet guns. Features include enclosed firing system, minimum debris, deep penetration, high well flow index, carrot-free. Widely used in both thru-tubing and slim hole work.

OTHER SMALL DIAMETER GUNS include the **LINK JET** and **TORNADO JET,** expendable thru-tubing perforators; and the **SIDEWINDER,** a retrievable jet perforator for slim hole operations.

SPECIAL APPLICATIONS

McCULLOUGH FOUR-WAY SQUEEZE JET GUNS – designed to assure even distribution of cement around casing. **FRAC-JET** – fires eight jets on a horizontal plane for fracture placement.

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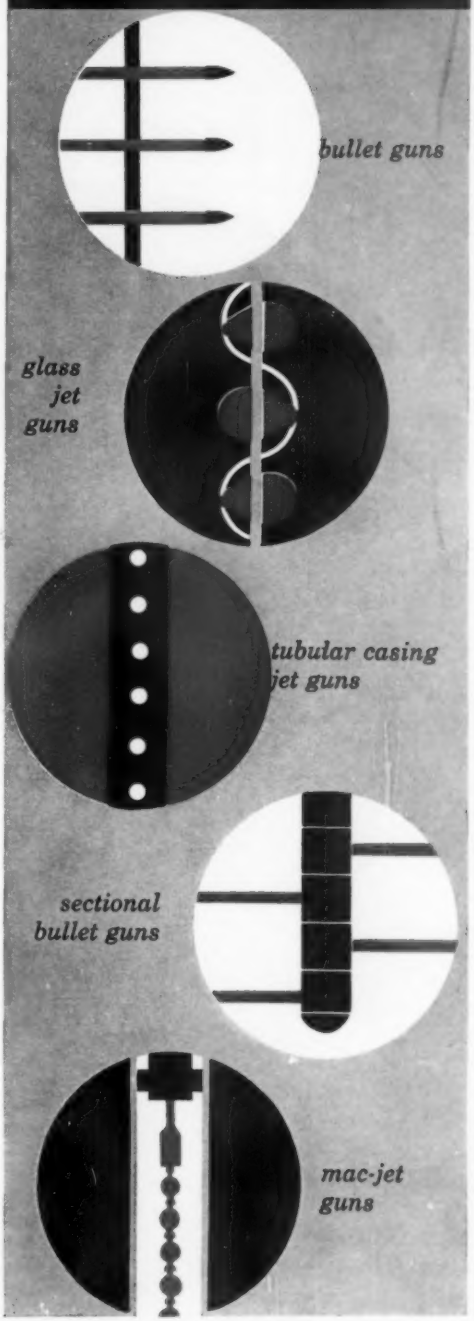
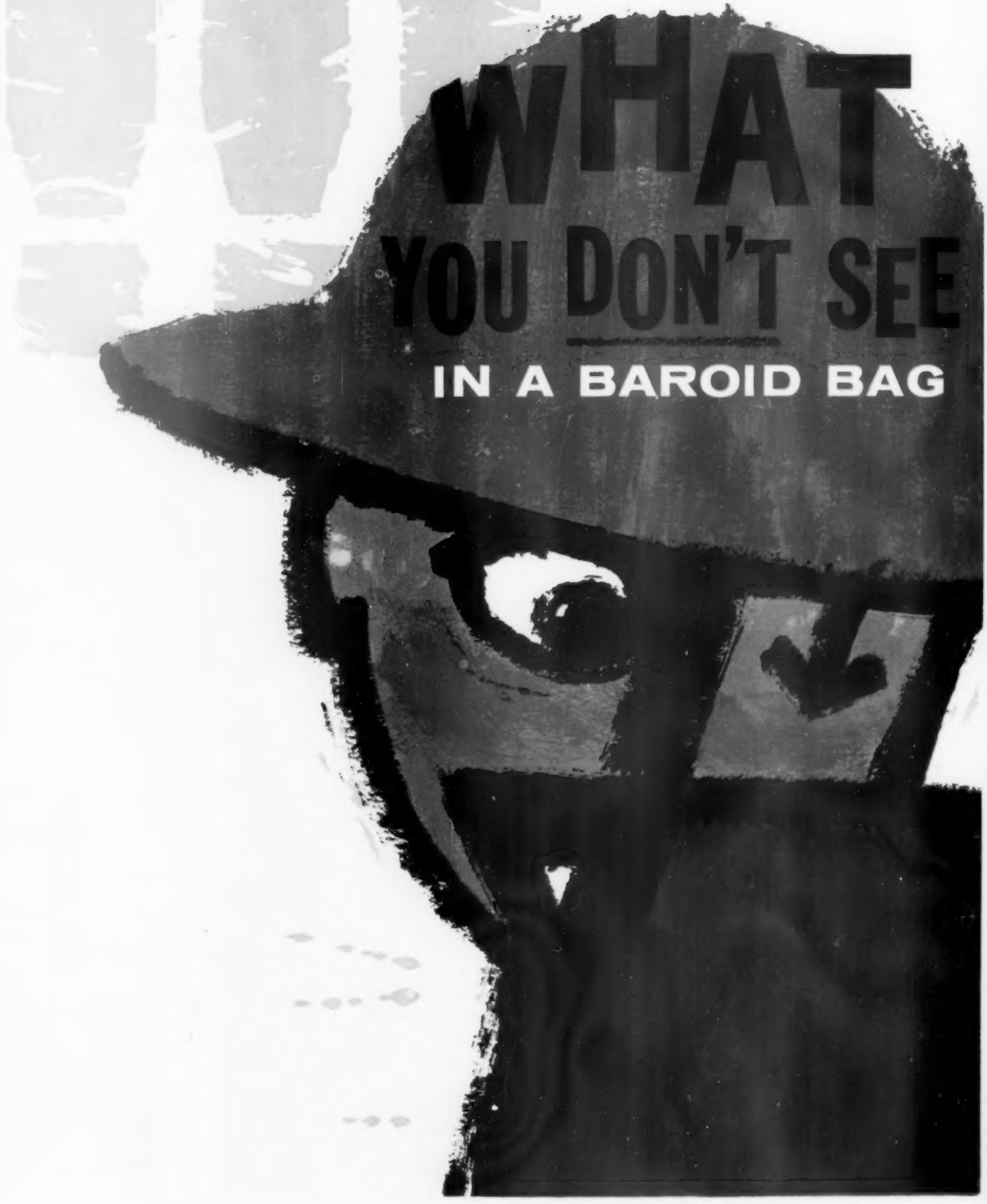


Baroid research has been active in the development



of every major break-through in drilling fluids!

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- 6,000+ man years of field engineering experience

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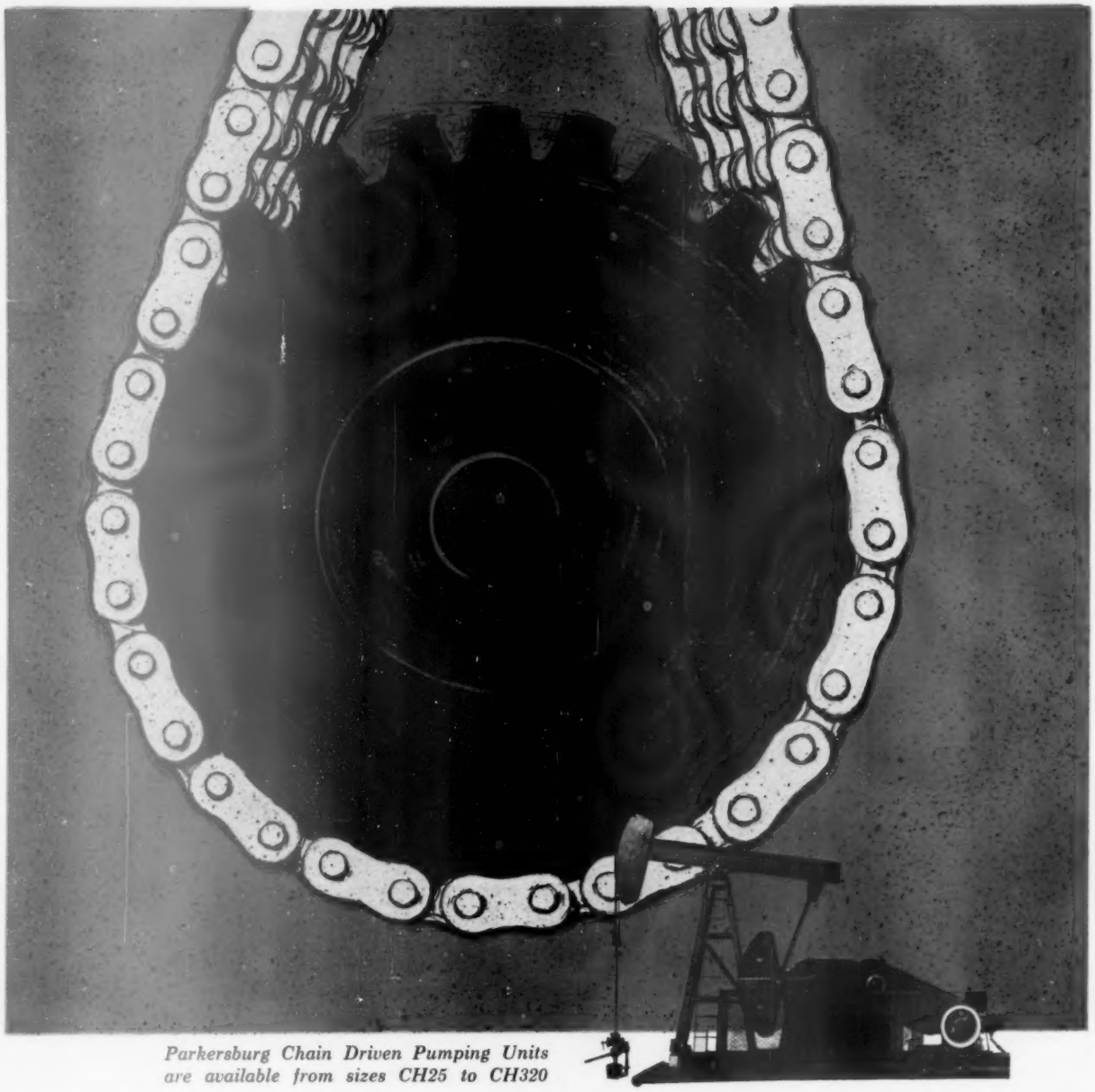

Parkersburg Chain Driven Pumping Units are available from sizes CH25 to CH320

CHAINED FOR ECONOMY Why a Parkersburg Chain Driven Pumping Unit? Consider the advantages. You get longer life — with precision heat treated chain and machined flame hardened sprockets. You get higher efficiency — less power loss — with tapered roller bearings throughout — and a chain drive is more efficient than gears. You get more shock absorbing capacity — less danger of damage — and a larger overload capacity. Down time and maintenance expense are small because chain adjustment is simple and quick — replacement chain is a stock item. Counterweights are easy to adjust. Parkersburg Chain Driven Units are easy to transport and install.

Let your Parkersburg representative give you additional reasons why Parkersburg Pumping Units will save you money.

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Division of Parkersburg-Aetna Corp.

HOUSTON • COFFEYVILLE • PARKERSBURG

the start of long liner life

The reason more Mission Liners are sold than all other makes together is simple: On well after well they have been proved best. Mission quality and superiority don't depend on chance; they are the sum of many carefully attended to details.

Take heat treating, for example. The induction hardening process which Mission uses can be more carefully controlled to a precise depth and hardness. The hardening is uniform, with no soft or thin spots to wear quickly. In tolerances, concentricity of ID and OD, surface finish, hardness, and fit, Mission Liners must meet the most exacting standards. Quality is the word for Mission pump parts. So, for greater pump efficiency, choose all Mission parts, first choice of the industry.

specify Mission all the way for greater pump efficiency

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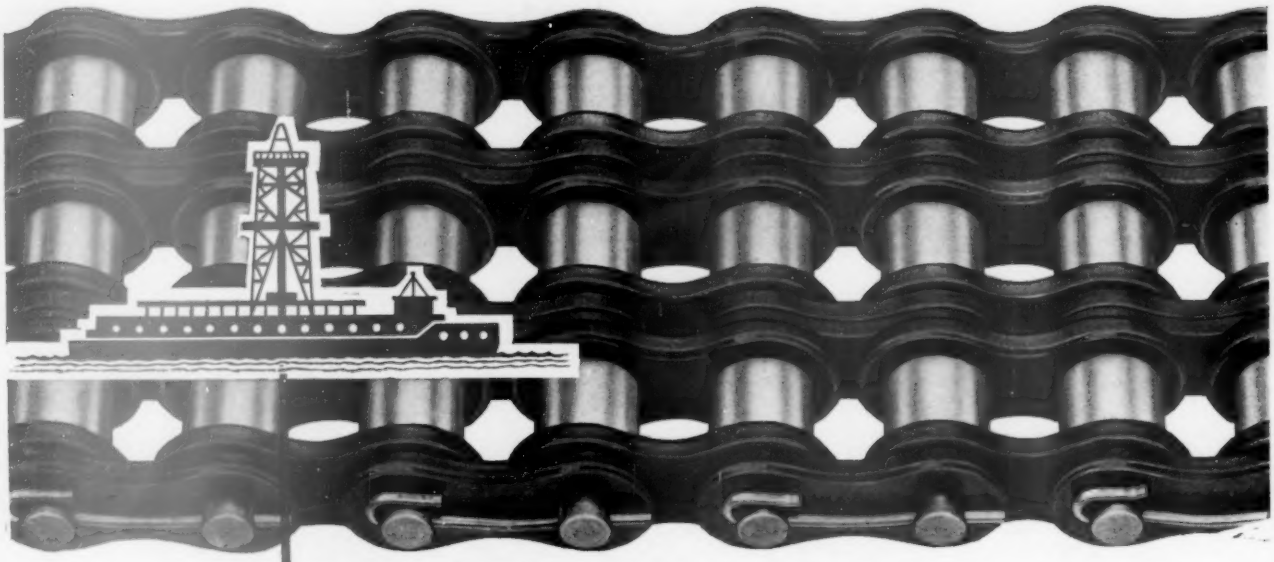
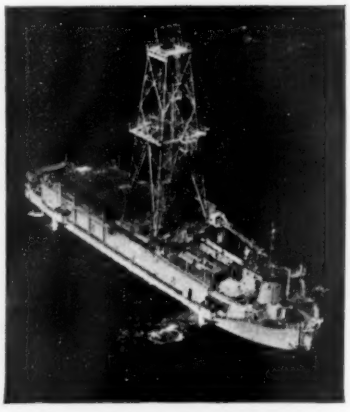
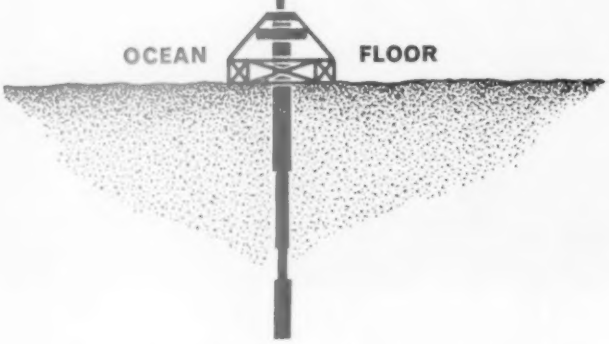
MISSION MANUFACTURING CO. P. O. Box 4209, Houston, Texas • Cable Address "MISSCO" Export Office: 30 Rockefeller Plaza, New York • In the United Kingdom: MISSION MANUFACTURING CO., LTD., 1 Hanover Square, London W. 1 England • cable address "MISSOMAN"



Link-Belt FR® roller chain delivered the power in historic deep-water probe



CUSS I, PROJECT Mohole's 3000 ton barge utilized four Diesel out-board engines to keep derrick in proper position over the hole, 2.3 miles below.



Several months ago, out in the Pacific, history was made. In 11,696 feet of turbulent sea, man probed closer to the earth's innards than ever before.

Link-Belt FR roller chain played a decisive role in this first phase of Project Mohole. It transmitted power to pumps and drawworks . . . helped control a quarter of a million pounds of drill string stretching down through unpredictable ocean currents.

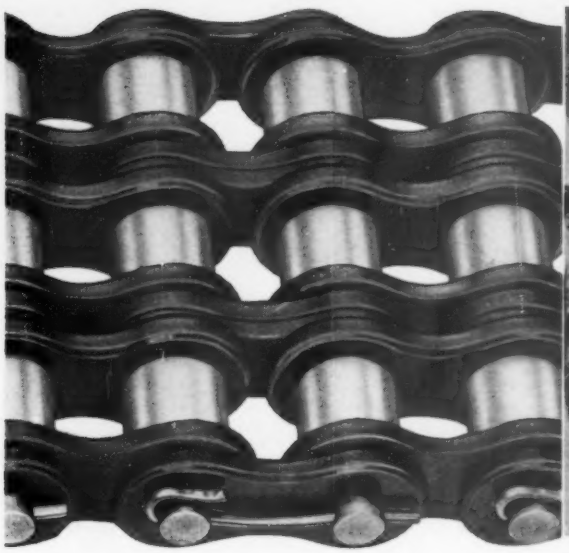
The unusual drive arrangement shown in illustration at right requires roller chain with capacity to withstand smashing impacts and tortuous stresses met in day to day drilling. The exceptional endurance required of equipment owned and operated by Global Marine Exploration Company is just another reason why Link-Belt FR roller chain has been the choice of rig manufacturers for many years.

For full data on the chain that assures *more on-bottom time,* ask any leading supply store for our Catalog 2980. And for engineering assistance in applying FR roller chain, write Link-Belt Company, Indianapolis, 6.

LINK-BELT

ROLLER CHAINS AND SPROCKETS

LINK-BELT COMPANY: Indianapolis 6, Houston 1, Dallas 6, Odessa, Tex., New Orleans 16, Shreveport, La., Los Angeles 22 (Montebello), Scarboro (Toronto 13); Export Office, New York 7. Distributors in All Fields. 15,743



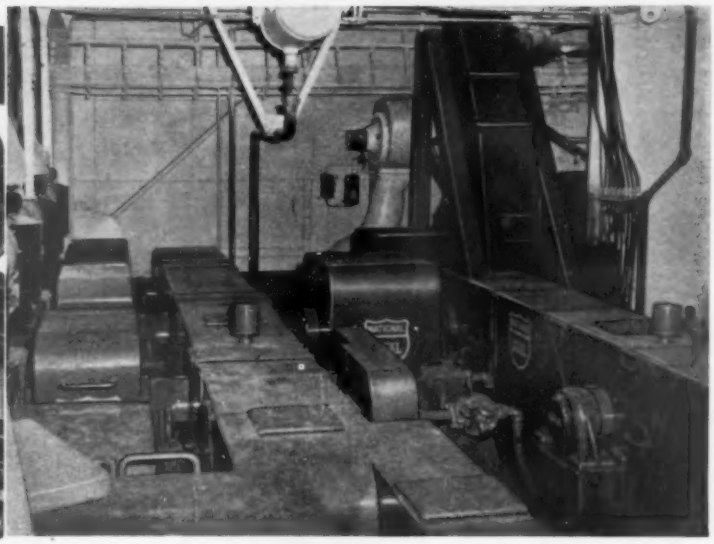
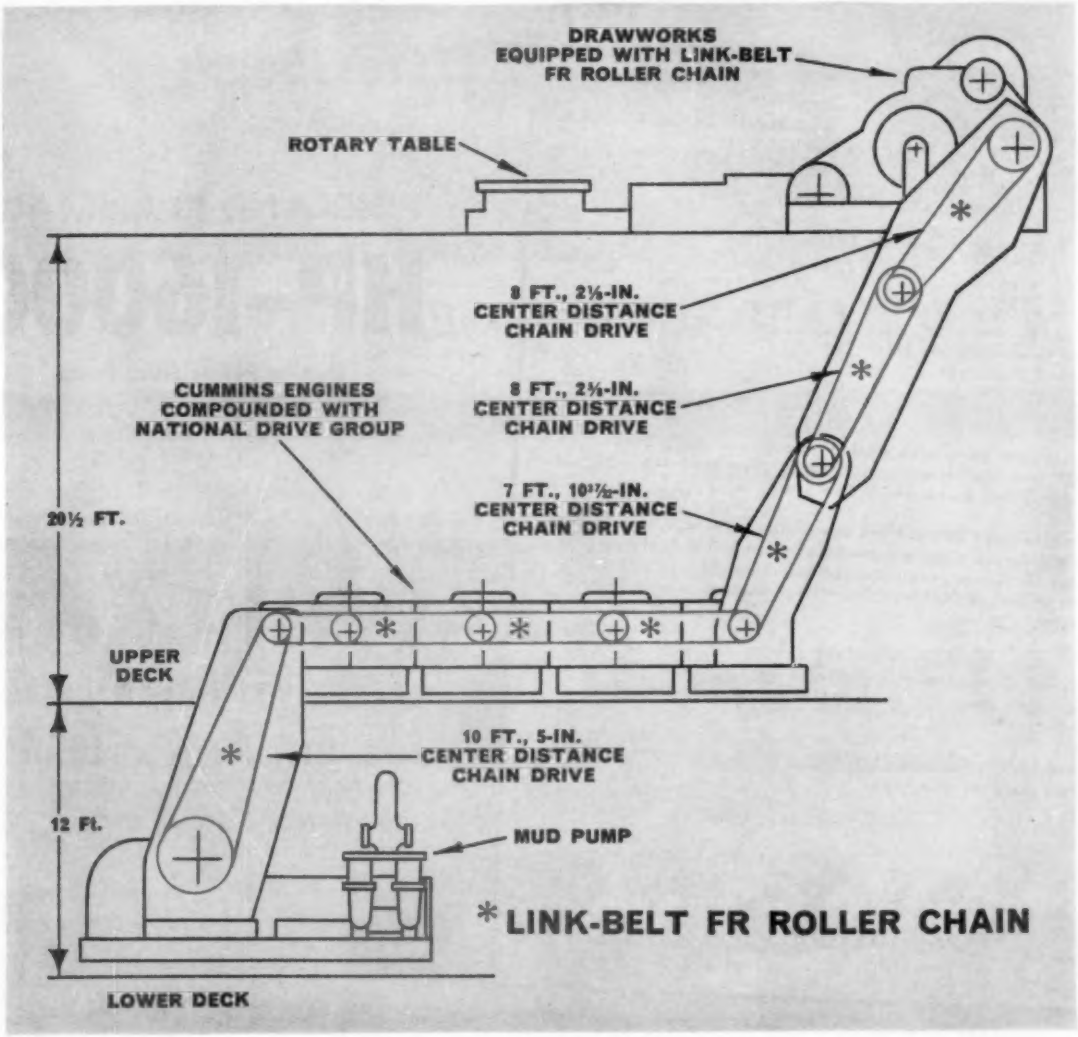
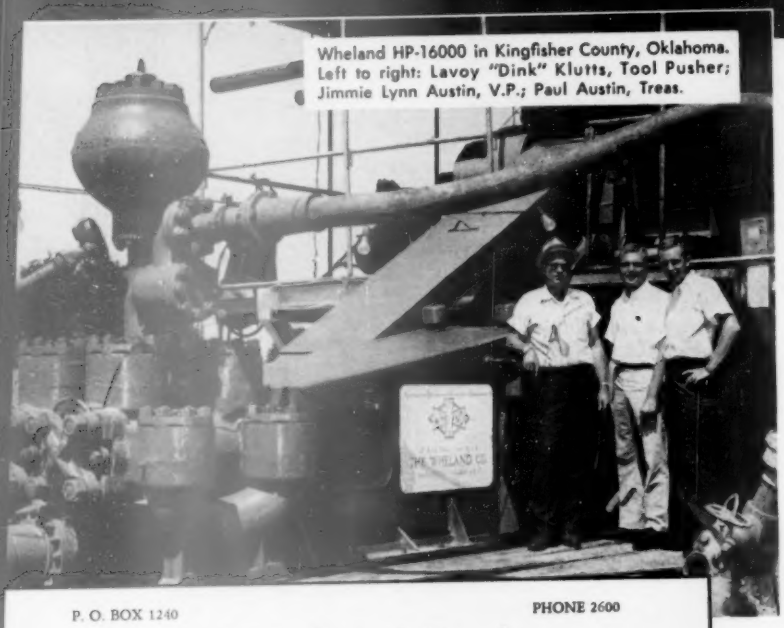


PHOTO OF NATIONAL SUPPLY DRIVE GROUP for compounding the power of Cummins engines required for operation of drawworks and mud pumps.



Only WHELAND
combines these features:



Wheland HP-16000 in Kingfisher County, Oklahoma. Left to right: Lavoy "Dink" Klutts, Tool Pusher; Jimmie Lynn Austin, V.P.; Paul Austin, Treas.

Planetary Gears
Oversize Bearings
Big Gear Reduction
Small Sheave
and Cylindrical
Crossheads

P. O. BOX 1240 PHONE 2600

Jimmie Austin & Sons, Inc.

Seminole, Oklahoma

August 1, 1961

Mr. Gordon P. Street, President
The Wheland Products
Division of Gordon Street, Inc.
Chattanooga, Tennessee

Dear Mr. Street:

As you know, we have used Wheland pumps for many years. From our own experience we became convinced that the Wheland HP-14000 Pump couldn't be beat.

But your planetary HP-16000 Pump is so quiet and smooth running that we are digging more hole faster and at less cost. Part of the increased penetration comes from the fact that the HP-16000 is bigger than the HP-14000. But that is only part of the story.

The new planetary gears let us use a much smaller sheave. The cylindrical crossheads, oversize bearings and the big gear reduction make the pump easier to pull, run smoother, and do a better job.

We have used this pump in Kingfisher County, Oklahoma, and find it just right for this area.

Yours very truly,

JIMMIE AUSTIN & SONS, INC.

By Jimmie Austin
President

JA:rmm

WHELAND PLANETARY

HP-16000

Duplex Power Slush Pump
7¾" x 16", 600 H.P. at 65 RPM

WHELAND

ROTARY DRILLING MACHINERY

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DIVISION OF GORDON STREET, INC.
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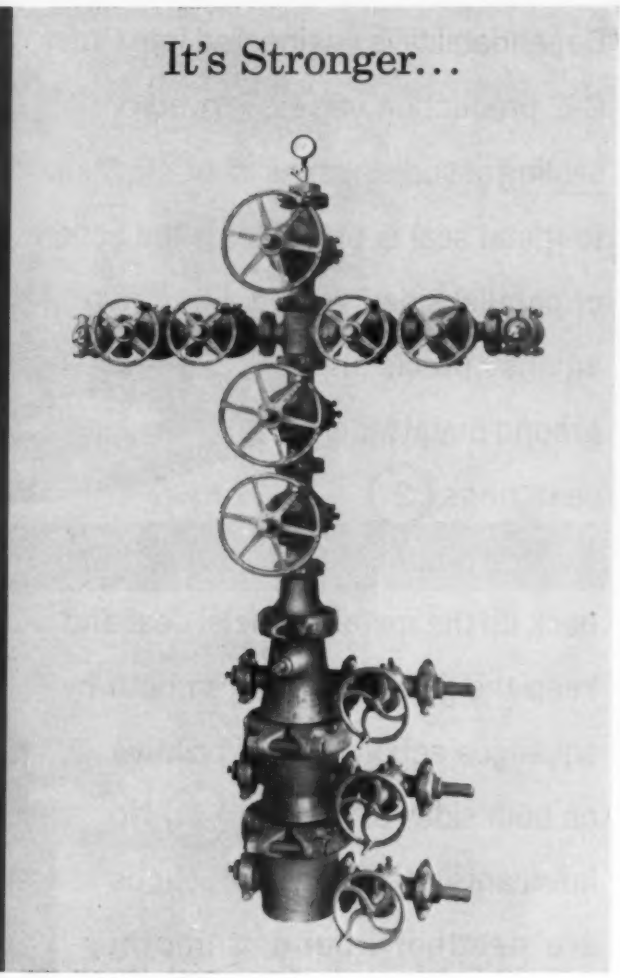


It's Better BECAUSE OF GRAYLOC

A Gray Well Head assembly, with GRAYLOC® connections, weighs about 26% less than a comparable flanged hook-up, yet it withstands an equal pressure. With only two bolts per connection, it's easier and quicker to nipple-up than flanged units and the assembled unit is about ⅓ smaller.

You save labor, space and time while getting the utmost blow-out protection and the longest possible stretch for your production dollar.

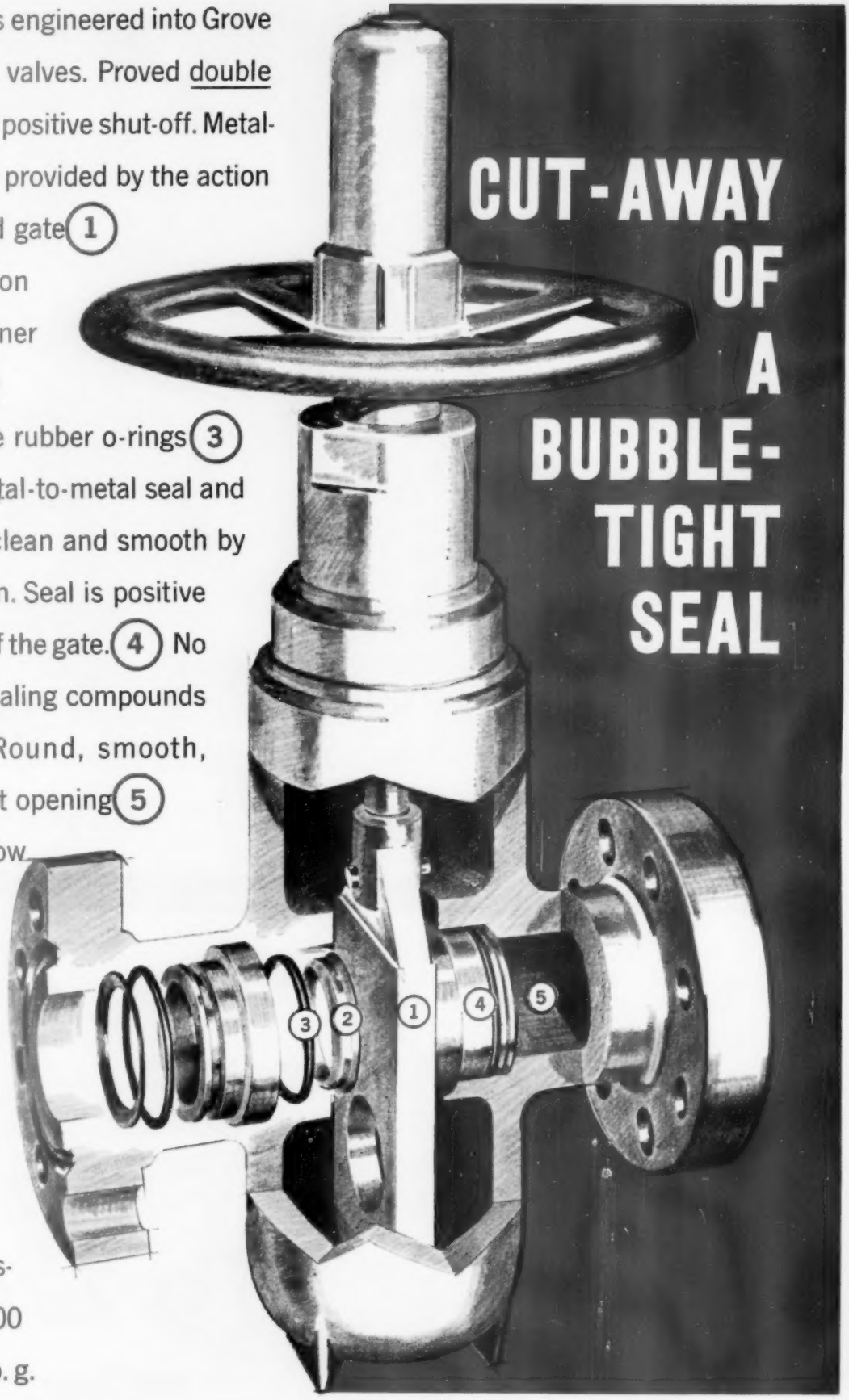
Why not let Gray assemblies help you bring your cost down? A great many of our customers have. Just ask your Gray representative or write today for more details.

	Flanged Assembly	GRAYLOC Assembly
Test Pressure	15,000	15,000
Height	136"	111"
Center to center of Flow Wings	95"	86"
Weight	6,591#	4,878#

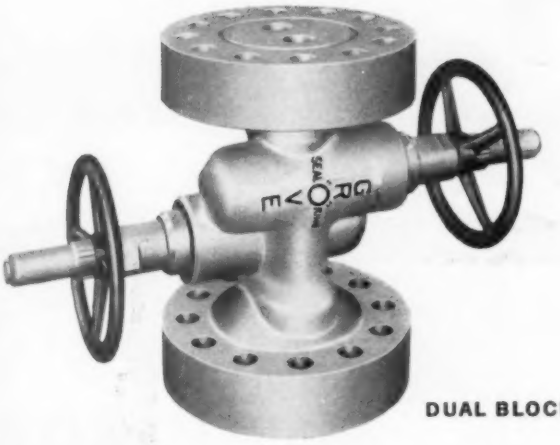
GRAY *Tool Company*

6102 P. O. BOX 2291 HOUSTON 1, TEXAS RIVERSIDE 7-1240

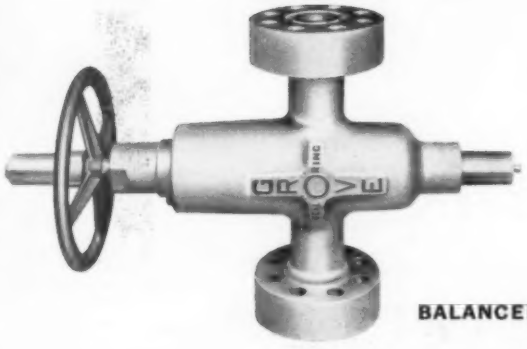
Dependability is engineered into Grove G-2 production valves. Proved double sealing assures positive shut-off. Metal-to-metal seal is provided by the action of parallel sided gate (1) against precision ground metal inner seat rings. (2) Protected nitrile rubber o-rings (3) back up the metal-to-metal seal and keep the gate clean and smooth by squeegee action. Seal is positive on both sides of the gate. (4) No lubricants or sealing compounds are needed. Round, smooth, through conduit opening (5) assures ideal flow characteristics and freedom to pass tools. Available also in dual block, balanced stem and recessed body types. Pressures from 1,000 to 10,000 # w. o. g.



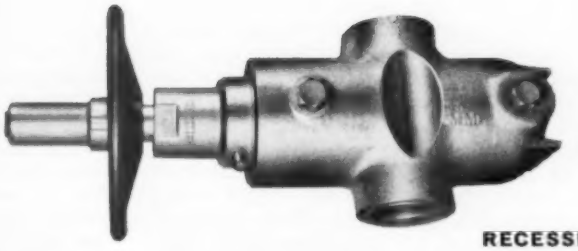
GROVE G-2 SEAL-"O"-RING® GATE VALVES FOR PRODUCTION AND FLOW LINE SERVICE



DUAL BLOCK



BALANCED STEM



RECESSED BODY

GROVE PRODUCTION VALVES

GROVE VALVE AND REGULATOR COMPANY

a subsidiary of Walworth

Oakland 8, California

Offices throughout the U.S. and in Western Canada

Sales

MINIMUM OF $8000 ON DRY HOLE COMPLETION TEST

LYNES Wildcat Open-Hole Test Service takes the gamble out of completion of questionable 8800-ft. New Mexico wildcat. Drill stem tests on a wildcat in the Artesia, New Mexico, area had been inconclusive so the operator was faced with the choice of setting casing, perforating, treating the formation and recovering the casing if the hole was a duster or of abandoning the well without additional testing at the risk of passing by a producer OR HE HAD THE CHOICE OF RUNNING A LYNES OPEN HOLE INFLATABLE WILDCAT TEST STRADDLE PACKER THAT WOULD ALLOW HIM TO MAKE POSITIVE WELL TESTS AT A VERY LOW COST.

Choosing the LYNES Test Service, the operator saved $8000 by eliminating normal completion and abandoning expense to conclusively prove the well dry—savings up to $20,000 have been reported. Had the well proved a producer, he would have saved a well that he might otherwise have abandoned rather than risk the cost of completing a dry hole.

The swab test through a LYNES Tool is more positive than a D.S.T., but the potential of the LYNES Test does not stop there. Stimulation treatment is a normal progression of this test—then further Swab Testing.

Many operators do not D.S.T. where results are expected to be questionable. They drill to T.D., then come back up hole testing all shows.

Single element tools can be opened above or below and straddle tools can be opened above, below or in between. LYNES Inflatable Tools can be reset anywhere in hole without tailpipe or formation anchor.

LYNES Inflatable Packers have endless variety of uses in testing, treating and production operations in the field. The inflatable sealing element will expand up to twice its run-in size to effectively seal in open hole or casing and will hold high differential pressures from above or below.

Ask your LYNES man to explain the many uses of LYNES packers to save you money on your well completions.

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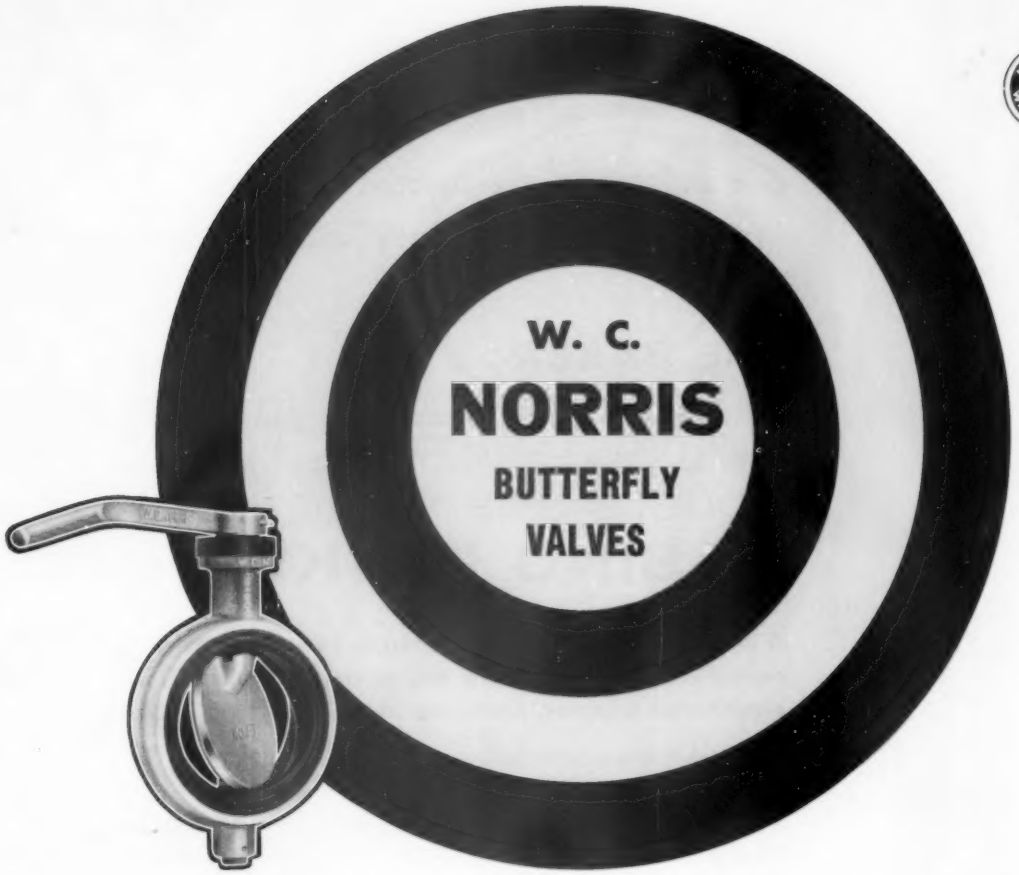

Target Versatility-Economy

Now you can reduce costs and simplify valve specifying by using the highly versatile and economical Norriseal Wafer Type Butterfly Valve. Designed for working pressures to 150 psi, the Norriseal Valve features removable and interchangeable rubber and metal seats . . . takes up less line space . . . can be easily and quickly removed for "on-the-spot" maintenance . . . is field repairable. The wide selection of trim available qualifies the Norriseal Valve for use in many oil field and industrial applications.

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An advanced new packer for production and well-stimulation

THE *BAKER* MODEL "R" DOUBLE-GRIP RETRIEVABLE CASING PACKER

A long-stroke (30″) packer with simple one-turn right control-pin setting, automatic bottom and hold-down ... for combination acidizing, fracturing and production operations.

Now Baker brings new convenience, new reliability, to the familiar long-stroke production packer with hold-down.

This results from a new design concept that moves the hold-down from the tubing to the packer, placing it below the bypass valve. This restores surface control of the bypass valve for pressure equalization, eliminates button dulling, and provides dependable release of the hold-down.

And, back of the Model "R" is the Baker service organization. Domestically, 62 Baker field-service warehouses stand ready to supply packers, parts and repair service. Ask one of the 400 Baker servicemen to give you the complete story on both the Double-Grip and Single-Grip (no hold-down) versions of the Model "R" Packer.

NEW
Face-Seal Bypass Valve
Seals instantly, is non-plugging

NEW
Differential Lock
Locks bypass valve closed; unlocks when tubing is picked up

NEW
Integral Hold-Down
Holds packer down, but does not interfere with use of bypass valve

Proven 3-Element Packing System

Dependable Rocker-type Slips

NEW
Automatic Bottom
Locks slips in retracted position when tubing is picked up

HERE'S HOW THE NEW DESIGN CONCEPT WORKS ...

(1) Note that the *Bypass Area* through the packer is completely isolated from the packer mandrel and tubing. Pressure surges in the tubing cannot dull buttons while running in or retrieving. Solids in tubing fluid cannot compact behind buttons and prevent retraction.

(2) Note that the *Hold-Down* is a part of the packer, not attached to the mandrel ... leaving the bypass valve free for instant pressure equalization.

(3) Note that a *Differential Lock* holds the bypass valve closed without requiring high set-down weights ... yet can be instantly released by picking up on the tubing.

The new concept in long-stroke packers is fully explained in Bulletin 385. Write: Baker Oil Tools, Inc., P. O. Box 2274 Terminal Annex, Los Angeles 54, California

BAKER
BAKER OIL TOOLS, INC.
HOUSTON / LOS ANGELES / NEW YORK

Authors check computer printout with well log in computer center at the University of Illinois.

by V. S. Tuman and Dorothy Bollman

Digital Computer: New Exploration Tool

To evaluate geological data from the exploration view, it is essential to discriminate between porous and nonporous formations. So, a digital computer program that discriminates sands from shales, using digitized SP curves or gamma ray logs, has been developed and tested at the University of Illinois.

The discriminating program, which was designed a year ago, already has been modified for greater flexibility and reliability. When input constants of the program are varied, the machine will discriminate between shales and shaly sands and clean sands, etc. It is feasible that the program can be made to bypass limestones or pick up only limestone beds if they meet a particular criterion.

Four different wells in the Illinois Basin have been evaluated to test this program. Three of them are pre-

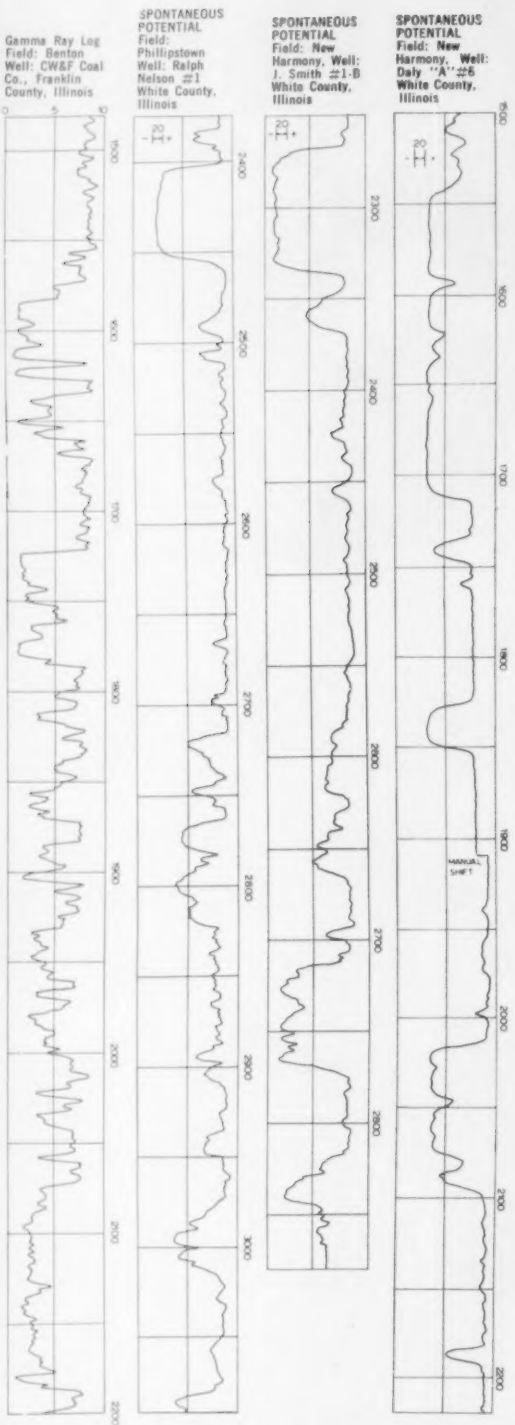


Fig. 1. Sections of three logs analyzed by this new digital computer process.

sented here in detail. Tables 1 to 3 compare computer results with visual discrimination. In Fig. 1 sections of these three logs are reproduced to indicate success and failure of the technique.

We feel that a more reliable picture of the discriminating program's accuracy will be obtained by the consideration of many more cases, since making the best choice of criteria is still largely a matter of human judgment.

Although the present program is designed to process existing data, the same logic can be applied to design similar programs for future digitized logs. We believe that in order to obtain the greatest benefits from computer application, programs must now be prepared for analyzing past and present well logs.

Program's Description

Purpose of the program is to discriminate between sands and shales on gamma ray or SP curves and to find the end points (i.e. top and bottom of each sand).

Think of the gamma ray or SP curve as a graph, letting well depth be the horizontal axis and SP or gamma ray be the vertical axis. Each sand is represented by a trough (Fig. 2) having a certain deflection and a certain width. For a trough to be selected, its width and deflection and slope of its sides must be equal to or greater than certain prescribed values (x, y and M respectively).

Basic sub-routines of the discriminating program are minimum point selection (MI) and maximum point selection (MA) routines. These routines are alternately entered to select relative minimums and relative maximums respectively. Both routines are entered via the main control routine (MC) (see the flow charts). After each entry to either MI or MA, MC makes various comparisons to determine whether or

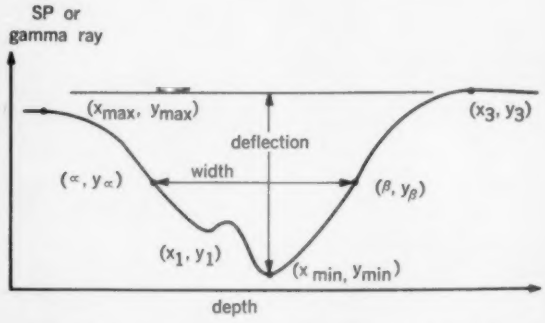


Fig. 2. Definition of measurements made on curves for computer analysis.

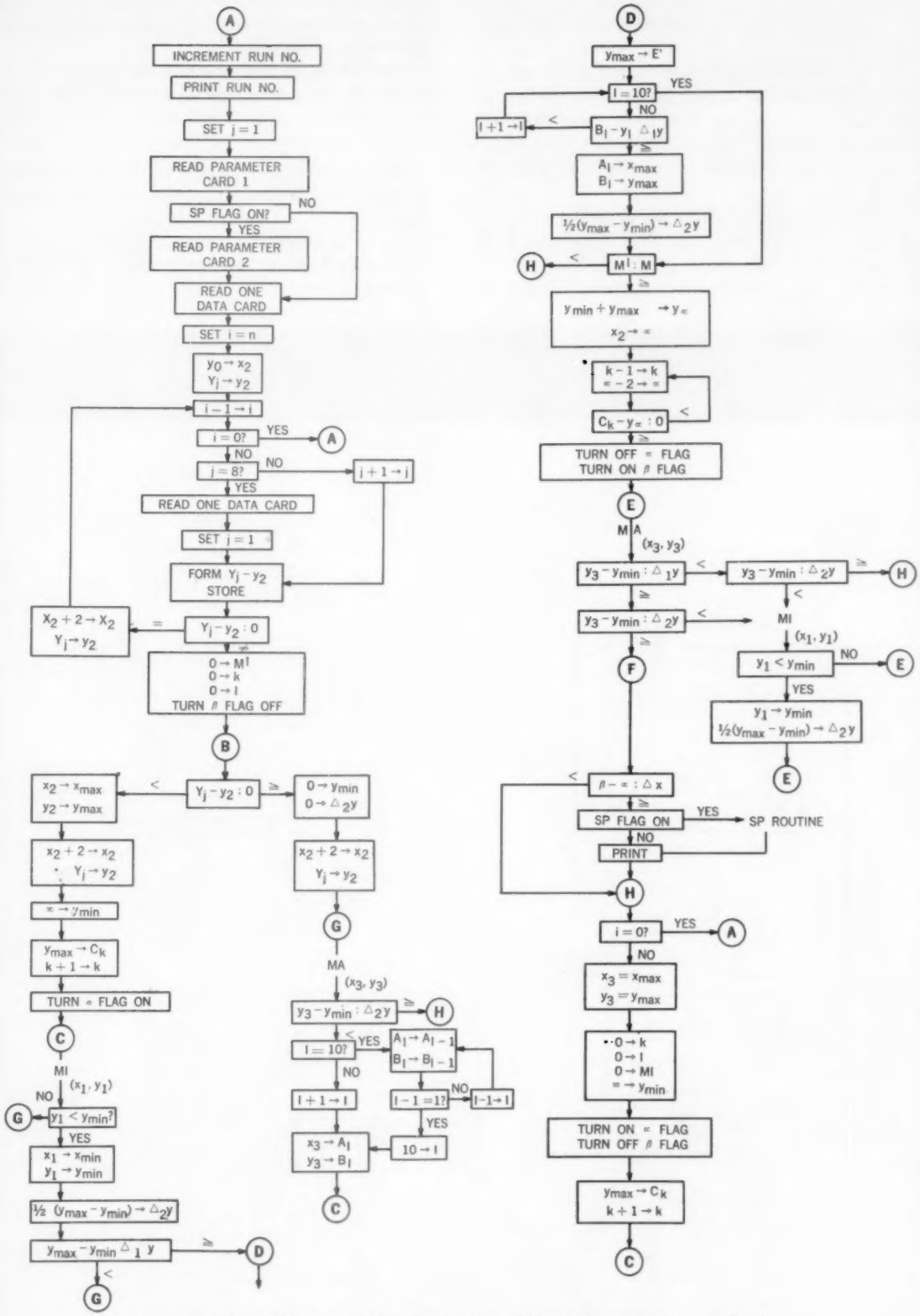


Fig. 3. Flow diagram indicating steps taken in computer analysis along with appropriate symbol of information and operation of computer.

not data presently being considered represent a sand.

It is assumed that the top of a sand has been reached when:

(1) A relative maximum (x_{max}, y_{max}) and a subsequent relative minimum (x_1, y_1) are found such that $y_{max} - y_1 \geqslant \Delta_1 y$ and such that no relative maximum occurs between (x_{max}, y_{max}) and (x_1, y_1) whose ordinate is equal to or greater than $\frac{1}{2}$ ($y_{max} - y_1$);

(2) The maximum slope between (x_{max}, y_{max}) and (x_1, y_1) is at least M. The slope check is incorporated to eliminate those sections which represent a gradual transition from shales to clean sands and vice versa. This program is very flexible, because by choosing an appropriate slope parameter, different classes of formations can be selected.

The left hand end point, α, of the sand is then taken to be the abscissa of the point whose ordinate is $y_\alpha = \frac{y_1 + y_{max}}{2}$.

When the beginning of a sand has been found, it is assumed that its end has been reached when:

(1) A subsequent relative maximum (x_2, y_2) is found having the property that $y_2 - y_{min} \geqslant \Delta_1 y$;

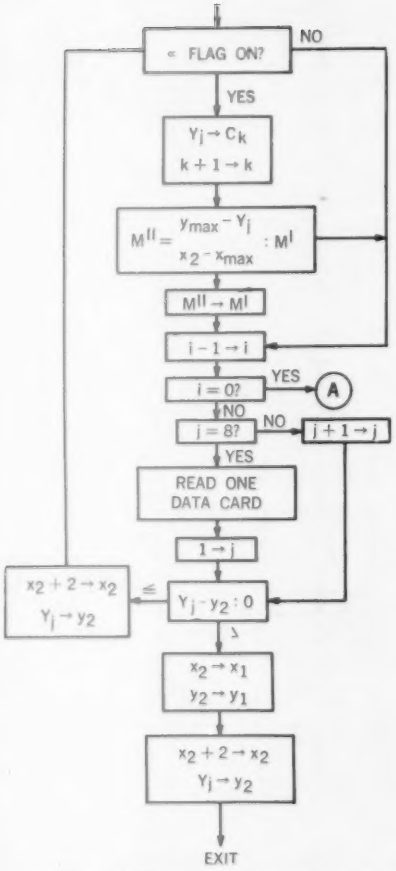


Fig. 4. Programming for minimum point selection and analysis.

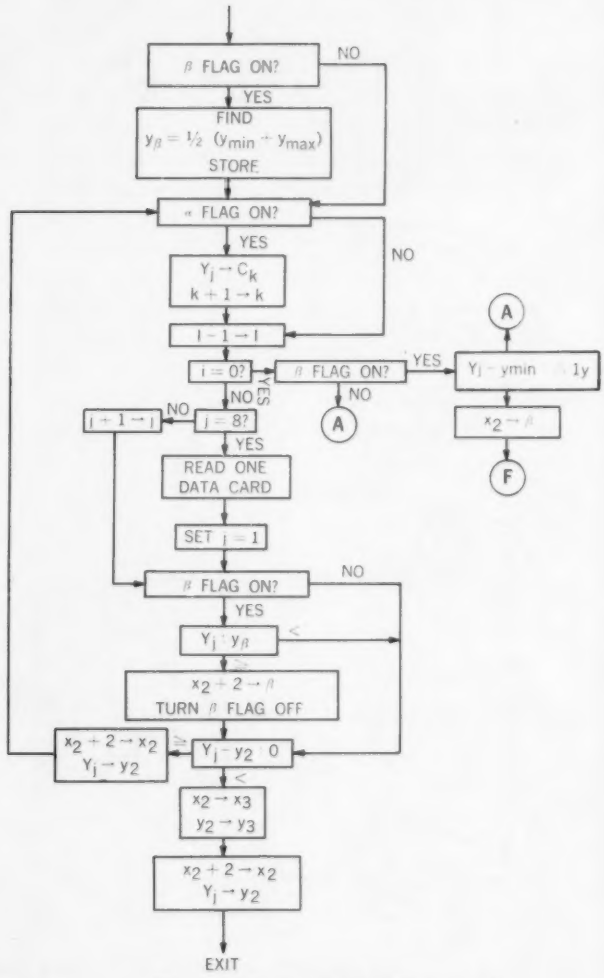


Fig. 5. Programming for maximum point selection and analysis.

(2) $y_3 - y_{min} \geq \frac{1}{2}(y_{max} - y_{min})$, where y_{min} is the absolute minimum for the particular sand. After such a point (x_3, y_3) has been found the right hand end point is determined by searching for the point prior to (x_3, y_3) whose ordinate is $y_\beta = \frac{1}{2}(y_{min} + y_3)$. The right hand end point, β, taken to be the abscissa corresponding to y_β.

If $\beta - \alpha \geq \Delta x$, α and β are printed and search is begun for a new sand.

SP Routine

Purpose of this program is to compute T_h (temperature), Rmf_h (mud resistivity) and Rw (water resistivity) at any depth h. It may be used simultaneously with the discriminating program, in which case the discriminating program will make entry to the SP routine each time a sand has been found. The discriminating program supplies SP with the depth h and the deflection E.

After having computed these values, control is transfered back to the discriminating program where α, β, T_h, Rmf_h, and Rw are printed.

Computations of these values are performed according to the following equations:

$$T_h = \frac{T_{bh} - 70}{H} \times h + 70$$

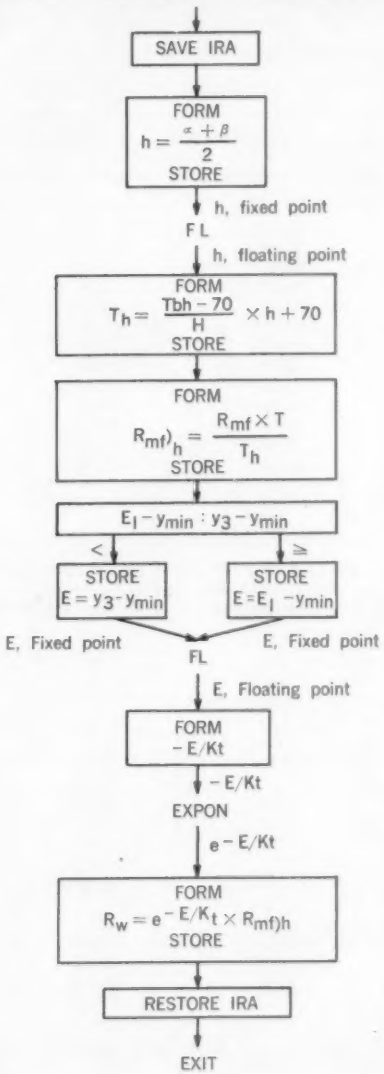


Fig. 6. Steps in analysis of self potential or the SP routine.

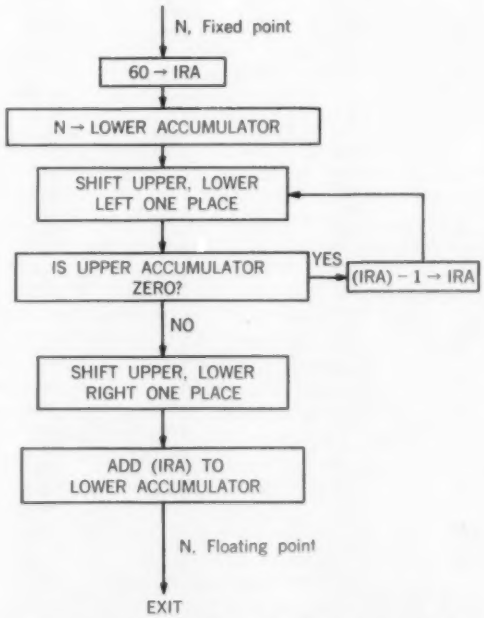


Fig. 7. Fixed point to floating point conversion in the FL routine of analysis.

$$Rmf_h = \frac{Rmf \times T}{T_h}$$

$$Rw = (e^{-E/K_t})\ Rmf$$

where

T_{bh} = bottomhole temperature
H = total depth drilled
K_t = SP constant
T = surface or bottom hole temperature
Rmf = mud filtrate resistivity at T

To compute e^{-E/K_t}, SP makes use of the University of Illinois' S5'-47' floating point exponential library routine.

The complete detailed logic of the discriminating and the SP routine are embodied in the accompanying flow charts.

Comments

Many factors differ greatly from sand to sand and from log to log, so one set of criteria that worked well on one log failed on another. Thus, a set of criteria that seemed to work most of the time had to be selected.

Two limitations, storage and time, affected accuracy in some cases. Since only eight ordinates were present in the memory at one time, the computer could look back at only a limited number of points at one time. This problem could have been eliminated if the input had been on magnetic tape. Subsequent and previous data would then have been accessible at any one time.

Although the University of Illinois' IBM 650 is equipped with magnetic tape units, punched card input was chosen since many installations do not have magnetic tape input.

The slope test was not always applicable. Slope of a trough was taken to be the maximum slope from (x_{max}, y_{max}) to (x_{min}, y_{min}). This is not always the slope which should be considered. However, to correct this, another search or more comparisons should have been made.

Table 1. Well: CW & F Coal Co., Franklin County, Ill.

Machine Discrimination		Visual Discrimination	
Top	Bottom	Top	Bottom
900	906	900	906
924	932	924	930
940	946	940	946
948	974	949	973
976	1018	977	1017
1042	1050	1041	1047
1054	1060	1053	1059
1064	1074	1064	1072
1098	1110	1098	1108
1156	1164	1157	1163
1174	1228	1175	1228
1234	1250	1234	1248
1254	1260	1252	1260
1264	1286	1264	1287
1310	1320	1311	1319
1328	1360	1327	1361
1396	1420	1396	1418[1]
1426	1440	1426	1438
1440	1458	1441	1455
1460	1468	1461	1472
1572	1618	1572	1617
1620	1628	1620	1627
1634	1654	1635	1653
1654	1660	1655	1660
1666	1672	1667	1671
1722	1754	1722	1753
1762	1782	1760	1785
1798	1806	1799	1805
1810	1818	1810	1819
1824	1830	1824	1828
1838	1846	1837	1848
1854	1872	1851	1871
1898	1906	1899	1906[2]
1930	1962	1931	1960
1964	1972	1965	1971
1976	1988	1974	1987[3]
2020	2026	2020	2025
2032	2042	2032	2041
2056	2062	2055	2060
2072	2176	2073	2177
2178	2184	2178	2186

1. Fairly shaly.
2. The sand at $\alpha = 1884$, $\beta = 1895$ was bypassed. Max and min were not recognized by the machine because the data were recorded at 2-ft intervals.
3. Shaly sand at $\alpha = 1991$, $\beta = 2002$.

Table 2. Well: Ralph Nelson No. 1, White County, Ill.

Machine Discrimination		Visual Discrimination	
Top	Bottom	Top	Bottom
2024	2034	2025	2033
2382	2392	2382	2391
2402	2454	2402	2455
2486	2496	2486	2496
2504	2510	2504	2510
2716	2730	2717	2733
2744	2752	2744	2751
2764	2782	2765	2781
2792	2806	2792	2806[1]
2890	2898	2890	2897
2980	3014	2980	3014
3082	3098	3082	3099
3118	3142	3119	3141

1. Program did not pick up subsequent sand at $\alpha = 2811$, $\beta = 2822$.

Table 3. Well: J. Smith No. 1-B, White County, Ill.

Machine Discrimination		Visual Discrimination	
Top	Bottom	Top	Bottom
224	296	232	295
312	338	314	337
508	540	509	537
1536	1550	1536	1549
1608	1644	1607	1642[1]
1728	1742	1710	1733[2]
		1734	1742[3]
1900	1908	1900	1909
1930	1940	1930	1939
1944	1954	1943	1953
1962	1972	1962	1972
2154	2204	2154	2203
2268	2336	2268	2335
2348	2366	2347	2367
2594	2622	2585	2621[4]
2644	2664	2641	2664
2694	2702	2694	2700
2712	2770	2713	2770
2828	2846	2821	2845

1. Shaly sand at $\alpha = 1647$, $\beta = 1662$ was not picked up.
2. Shaly.
3. Relatively clean sand.
4. Shaly sand.

However, such a change would have been much more expensive in machine time.

Also, the assumption that the end of a sand has occurred when $(y_3 - y_{min}) \geq \frac{1}{2}(y_{max} - y_{min})$ was sometimes fallacious. For example, part of one sand was missed because of this criterion. The assumption originally was made in order to eliminate shaly parts at the beginning of sands. This problem might have been eliminated if the computer had had access to prior data.

In the logs considered, digitization of curves was made at 2-ft intervals. It is felt that this is sufficient in most cases. Occasionally, however, a sand might be missed because critical maximum or minimum points fall between the digitized points. In these exceptional cases the data will not represent the true curve.

In the three logs run at the University of Illinois, the discriminating program was successful most of the time.

Acknowledgments

Gratitude is expressed to the California Research Corp. for its generous grant to support this project, and special thanks are extended to Professor A. J. de Witte for reading the manuscript and making useful comments.

References

1. Slack, H. A., et al, "Electric Log Interpretation in Exploring for Stratigraphic Traps in Shaly Sands" AAPG Bulletin, Dec. 1960, V. 44, No. 12, p. 1874.

2. Tuman, Vladimir S., et al, "Application of Computers to the Interpretation of Well Logs" Journal of Petroleum Technology, April 1961.

Nomenclature

(x_1, y_1) = Coordinates of last minimum encountered.

(x_2, y_2) = Coordinates of last point encountered.

(x_3, y_3) = Coordinates of last maximum encountered.

(x_{max}, y_{max}) = First maximum of sand prior to a (x_1, y_1) having the property that $y_{max} - y_1 \geq \Delta_1 y$

(x_{min}, y_{min}) = Coordinates of absolute minimum of sand.

(α, Y_α) = Coordinates of left hand end point of sand.

(β, Y_β) = Coordinates of right hand end point of sand.

M′ = Maximum slope encountered in a particular sand.

E′ = Ordinate of first maximum point of sand.

Run No. = Identifying number which distinguished beginning and end of outputs from successive logs. Initially it is set to zero, and then is incremented by one for each new log.

Flags

α flag = This flag is either 0 (off) or 1 (on). If it is on, the program will start storing data in block C.

β flag = This flag is either 0 (off) or 1 (on). If it is on, the program will begin its search for y_β.

SP flag = This flag is either 0 (off) or 1 (on). If it is on, the SP routine will be executed. If it is off, SP will be bypassed.

Counters

i: (IRA) = Counter which keeps track of the number of points processed. At the beginning of a log, i = n and at the end i = 0.

j: (IRB) = Counter which keeps track of number of points processed on a particular card. Each time a data card has been read, j is set to 1 and when the card has been processed j = 8. j also serves as a tag for specifying locations within block Y.

k: (IRC) = Tag specifying locations within block C.

l = Tag specifying locations within blocks A and B.

Storage Blocks

A and B = Contain abscissas and ordinates, respectively, of all maximums in a particular sand, prior to that point (x_1, y_1) for which $y_{max} - y_1 \geq \Delta_1 y$.

Y = Contains ordinates from one data card.

About the Authors

When Vladimir S. Tuman joined the University of Illinois' mining and metallurgical engineering department as an associate professor in 1959, he discovered that the Illinois geological survey had a very large number of well logs available. His interest in formation evaluation led him to explore the possibilities of using digital computers to evaluate petrophysical properties of rocks from wells logs, a project later supported by a California Research Corp. grant. Tuman has attended Abadan Technical School, received a BS in physics from England's Birmingham University and a DIC from the Imperial College of Science and Technology in London. He worked for the Anglo-Iranian Oil Co. and, during nationalization of the Iranian oil industry, was transferred to the petroleum engineering department. He later was appointed acting chief petroleum engineer for the National Iranian Oil Co. From 1954 until 1957 he worked for the Consortium, then came to the United States. He worked for Atlantic Refining Co. until accepting his university post.

Dorothy Bollman currently is working for a PhD in mathematics at the University of Illinois, where she also holds a part-time teaching assistantship. She has a BS degree from Eastern Illinois University and an MS from the University of Illinois. She has held positions as a digital computer programmer at Douglas Aircraft Co. and Ramo-Wooldridge Corp. ■

Slim Hole Ltd. Rig 1 on location in swamps of South Louisiana about 35 miles north of New Orleans. Rig is moved with ten truck loads and uses an 80-ft by 80-ft turnaround.

Slim Holes Save In South Louisiana

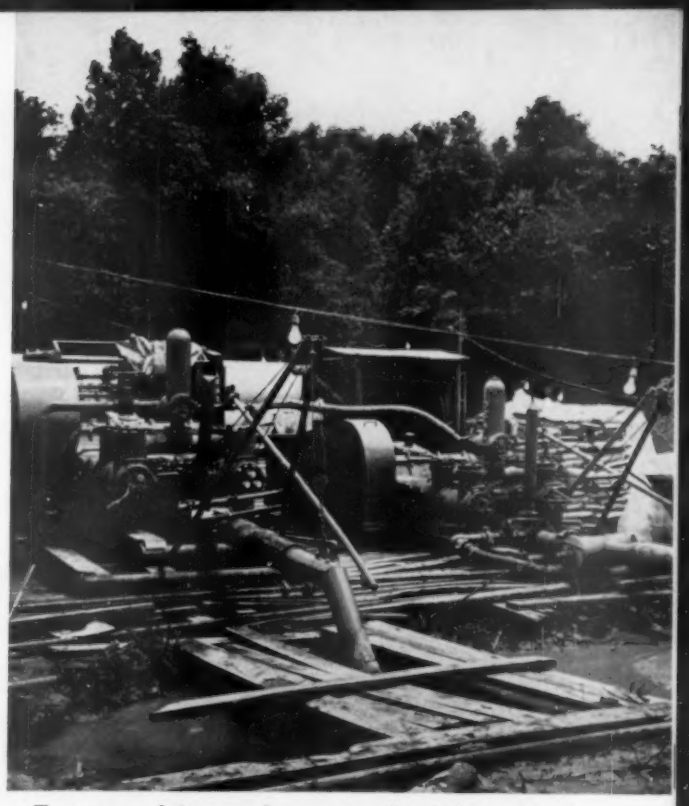
Slimhole drilling and tubingless completions in South Louisiana are saving plenty of money and giving new life to areas previously classified as marginal or non-economical. Slim holes, too, are providing an economical means of exploring prospective locations of less than 12,000 ft in depth.

Proving this is the field work that has been done by Slim Hole Ltd. of Lafayette, La.

The idea of slimhole drilling was proposed in detail as early as 1941 by I. W. Alcorn of The Pure Oil Co. Slim Hole Ltd. has been drilling slim holes since the fall of 1959. Since that time, this firm has drilled over 30, 6000-11,000-ft wells with hole sizes of 6⅛ and 6¾-in. diam, establishing slimhole practices for South Louisiana oil and gas development wells. No undue trouble has been encountered, and costs have been trimmed considerably. Especially, savings have been substantial in well completions.

Of 30 slim holes, four have been completed with 4½-in. OD casing. The deepest, to a total depth of 10,600 ft, was in the Raceland field of Lafourche Parish. A gas well, it was completed in the routine manner with tubing set on a packer above the producing interval. The recent completion of the B.M. Hester No. 1 Laughlin well in the Bayou Mallet field of Acadia Parish marks the third successful tubingless completion in a slim hole for this field since January 1961.

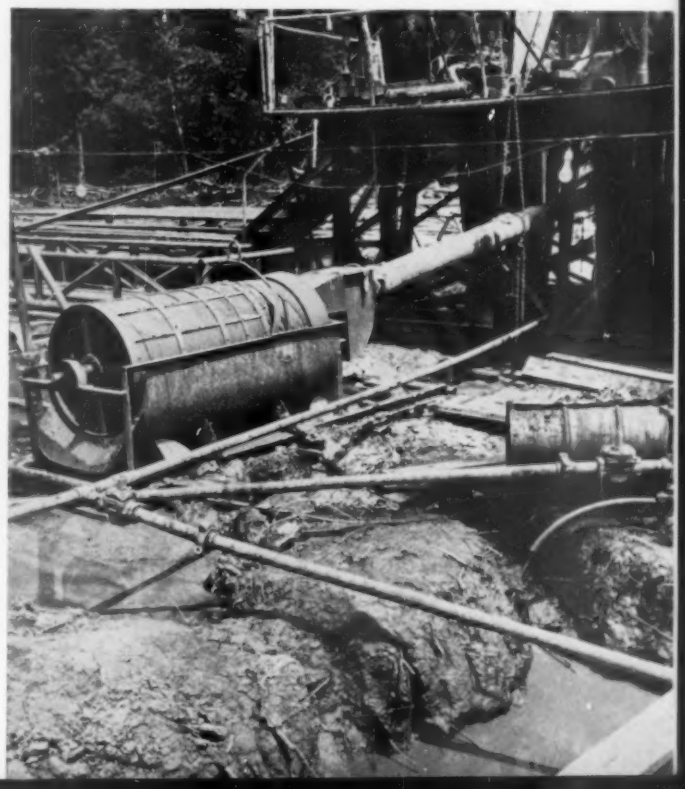
Hole and casing size programs have been altered for slim holes, resulting in considerable cost reductions. The slimhole program employs



Two power driven mud pumps are located on edge of 80-ft by 80-ft board turnaround with mud suction pits located adjacent to turnaround.

by Frank Perkins, Jr. — D. B. McClinton

Self-powered rotating shale shaker discharges into ditch and return mud flows into settling pit at lower right. Chemical treatment for mud is added from drum at right.



a 7-in. surface casing string instead of a 10¾-in. surface casing. The surface hole is drilled with 9⅞-in. jet bit instead of 12¼-in. Depth of this surface hole is between 1300 and 1400 ft. Cost of the 7-in. pipe is about $1.90 per ft for new pipe and $1.50 for good quality used pipe. This compares to $4.50 per ft for new 10¾-in. casing.

In tubingless completions, 2⅞-in. pressure-tested tubing is run in the 6⅛-in. hole below the 7-in. surface pipe. Cost of this tubing is 60¢ per ft, including a pressure test to 6500 psi.

At Bayou Mallet, one or two additional bits (6⅛-in.) are required over the number of 8¾-in. or 9⅞-in. bits used in conventional wells drilled by large rigs. One to two days are added to the drilling time for the slimhole program, bringing the price per ft of hole drilled slightly under the cost per ft for the larger rig.

Experience indicates that formation evaluation appears to be superior in smaller holes. And, sidewall core recovery in these small holes exceeds the average for South Louisiana. At Bayou Mallet, sidewall cores in the 6⅛-in. holes

Blowout preventer hookup on slimhole rig while drilling below 7000 ft on 10,000-ft well with 2⅞-in. OD drill pipe and 4¾-in. OD drill collars.

average 1-in. long with recoveries exceeding 90%.

Program at Bayou Mallet

Three slimhole-drilled tubingless completed wells at Bayou Mallet so far this year have been almost identical. But a specific well, the No. 1 Laughlin, will indicate actual practices.

After clearing location, an 80-ft by 80-ft board turn-around was built and earthern mud pits dug along one side. Drawworks of the slimhole rig is powered by a 260-hp gas engine. Mast is 97 ft high with a capacity of 325,000 lb load.

Butane to fuel the pump engines and drawworks engine is supplied by this tank-trailer that also serves for storage.

Completed well ready for cleaning and painting. This is a tubingless completion in the Bayou Mallet field of Acadia Parish, showing simplified tree hookup.

Two power mud pumps are used. One has a rated input of 370 hp at 65 spm, the other 220 hp at 70 spm. Drill pipe is 2⅞-in. OD N-80 tubing with 4⅛-in. OD flash welded tool joints. Drill collar size is 4¾-in. OD.

A 9⅞-in. surface hole was drilled to 1450 ft and 7-in. OD, 23-lb J-55 casing set at 1435 ft with 350 sacks of cement.

After cement had set, a 6⅛-in. hole was drilled to 9250 ft with 10 jet bits. A water-base mud was used to total depth. Weight near total depth was 9.9 lb per gas; viscosity, 50 sec and water loss held to 10 cc. Upon reaching total depth, the hole was conditioned for one hr and an induction log run from TD to bottom of surface casing. A Microlog was made of the pay section and 15 sidewall cores taken. Core recovery was 93%. Core analyses were made in the laboratory.

The hole was conditioned again and drill pipe laid down. Tubing-for-casing, 2⅞-in. OD, 6.5 lb per ft, was run to bottom and cemented with 300 sacks of cement. Rig was released to move on next location. Total drilling time from spud to log was only 14 days.

How Savings Were Realized

Exclusive of tank battery, total cost of the completed No. 1 Laughlin well was about $50,000. Table 1 shows cost breakdown for another Bayou Mallet tubingless completion to 9350 ft.

Savings began with the 80-ft by 80-ft turnaround as compared to a 100-ft by 150-ft turnaround required by a conventional 10,000-ft rig. Use of 7-in. instead of 10¾-in. surface cas-

Table 1. Drilling and Completion Costs for Tubingless Completion at Bayou Mallet Field.

Drilling Costs		
9250 ft @ $2.85/ft	=	$25,962
1400 ft 7-in. Surface Csg	=	$ 2,800
Cementing Surface Csg	=	$ 1,080
Drilling Mud & Chemicals	=	$ 735
		$30,577
Two Logs and Sidewall Cores	=	3,000
Cost to Csg Point	=	$33,577
Completion Costs		
Rig — $700/day for 2 days	=	$ 1,400
2⅞-in. Casing @ $1.00/ft	=	$ 9,200
Perforating	=	$ 800
Cementing, Centralizers and Scratchers	=	$ 1,200
		$13,800
Total Well Costs, less location and tank battery	=	$33,577 (drilling and logging)
		$13,800 (completion)
		$47,377

ing, as well as cementing cost of each, made considerable reduction in cost.

Making the big difference in completion cost is the production casing string, which, in the case of a slimhole completion, could be 4½-in. A conventional completion would take either 5½-in. or 7-in. The tubingless completion on the No. 1 Laughlin used 2⅞-in. tubing for casing.

Smaller bits cost less, as well as the mud system of less volume than that of conventional hole size. Total mud and mud chemical bill on the No. 1 Laughlin well was slightly less than $1000.

Table 2 gives a more detailed cost breakdown comparison between various drilling and completion methods for a 10,000-ft well requiring 1800 ft of surface casing.

Table 2. Comparative Drilling and Completion Costs for Various Possible Programs for a Single Zone Completion in South Louisiana on a 10,000-ft Development Well Requiring 1800 ft of Surface Casing.

DRILLING METHODS				
Slim Hole (6⅛ to 7⅞-in.)				
Location		960		
Surface	(7-in.)	3,456	(8⅝-in.)	5,724
Cementing		1,180		1,626
Mud		2,800		3,300
Drilling		30,000		32,500
Logging		1,450		1,450
Cost to Casing Point		$39,846		$45,560
Conventional Hole (8¾ to 9⅞-in.)				
Location		2250		
Surface	(9⅝-in.)	6,426	(10¾-in.)	8,100
Cementing		1,810		2,187
Mud		3,600		3,800
Drilling		36,000		37,500
Logging		1,450		1,450
Cost to Casing Point		$51,536		$55,287
POSSIBLE COMPLETION METHODS				
Slim Hole Completions				
		(Standard)		(Tubingless)
Prod. String (4½-in.)		16,000	(2⅞-in.)	10,165
Cementing		920		1,110
Tubing (N-80) (2⅜-in.)		7,662		—
		$24,582		$11,275
Cost to Completion Point		$64,428		$51,121 (Min)
Conventional Completions				
		(Standard)		(Standard)
Prod. String (4½-in.)		16,000	(5½-in.)	21,660
Cementing		1,180		1,050
Tubing (2⅜-in.)		7,662	(2⅜-in.)	7,662
		$24,842		$30,372
Cost to Completion Point		$70,402		$75,932
Conventional Completions				
		(Standard)		(Standard)
Prod. String (5 1/2-in.)		21,660	(7-in.)	33,050
Cementing		1,190		1,243
Tubing (2⅞-in.)		10,168	(2⅞-in.)	10,165
		$33,015		$44,458
Cost to Completion Point		$84,551		$99,745

Note: (1) 80 ft x 80 ft turnaround for SH rig. 100 ft x 150 ft turnaround for conventional rig.
(2) Mud and drilling costs estimated.
(3) Cementing surface casing to surface. Cementing production string up 1000 ft.
(4) Engineered casing programs.
(5) All tubing N-80.

Performing Well Work

Experience to date indicates that all open hole work such as logging and coring in a 6⅛-in. hole is routine and that equal or better results are possible. Also, workovers inside 2⅞-in. OD tubing for casing (tubingless completion) have been performed successfully with 1-in. OD tubing or with wireline.

The No. 1 Laughlin well showed on first test after cementing that the 2⅞-in. tubing-for-casing leaked. Wireline methods located the leak at 7100 ft. A small workover unit squeezed the pipe at this depth by using 1-in. OD tubing. The repair job took about three days, after which the well was completed and immediately began to flow.

On another recent tubingless completion in Jeff Davis Parish, the 2⅞-in. tubing-for-casing had sanded up. One-in. tubing was lowered into the well, and the sand was circulated out without any difficulty.

In still another tubingless completion, the well began to make over 50% water as a result of perforations near the water-oil contact which resulted in channeling. Perforations were squeeze-cemented down the 2⅞-in. pipe and over-displaced with oil. The well flowed no water when later re-perforated higher in the pay zone.

Savings and Conversions

Experience and case histories to date show that slimhole drilling techniques lend themselves to both development and exploratory wells. The tubingless completion employing 2⅞-in. OD tubing-for-casing has reduced completed well costs by almost 40% compared to conventional 5½-in. OD casing with 2⅜-in. OD tubing completion.

Recent developments in small bore downhole equipment . . . such as packers, squeeze tools, perforating and logging tools, etc. . . permit all below-surface work in small bores (4½ and 2⅞-in.) that can be done in larger size casing, excluding multiple completions, of course. A tubingless completion with 2⅞-in. OD tubing-for-casing can be converted easily to a conventional completion by using 1 or 1½-in. OD tubing and 2½-in. packer. ■

by Frank M. Pool

Save With Slim Holes In Hard Rock Country

In hard rock country such as the Permian Basin it's more economical to drill slim holes than larger wells, provided you use the right equipment and make necessary preparations. At least this is true for wells of moderate depth.

And obviously, you can't economically drill a 7500-ft hole for 5-in. casing with the same rig, drill pipe and drill collars that you would use to drill a conventional hole.

Use of drill tubing or thin-wall drill pipe with lower requirements of drill collar weight will reduce drawworks horsepower requirements by approximately 40% while hydraulic horsepower required remains constant or increases only slightly.

With the substantial reduction in rig requirements, there are tangible savings in fuel, maintenance, insurance, depreciation, moving costs, rig-up and rig-down costs, wireline and other supplies. Labor, taxes and other fixed costs represent approximately 40% and bit costs around 15%; there remains 45% of total costs to which a rig requirement saving could be applied. With a conservative 25% saving realized on a slimhole rig operation, then the overall saving should be approximately 10 to 12%.

There is 27% less drilling fluid required in a 6¾-in. hole than in a 7⅞-in. hole, and 37% less in a 6¼-in. hole. This not only reduces water and mud costs but also reduces earthen reserve pit and steel pit requirements. Some slimhole contractors have successfully used one steel pit with three partitions.

Penetration and Bit Life

The streamlining of rigs and drill string alone will not provide a more economical operation unless drilling performance in small holes can be made comparable to that in drilling conventional holes. The two key factors are penetration rate and feet drilled per bit.

Rates of penetration in slimhole drilling in relatively soft, unconsolidated formations compare favorably with the rates in conventional hole sizes. This has been found to be especially true in South Louisiana, Mississippi and the Gulf Coast area. Feet drilled per bit is also favorable making possible a net reduction in costs in drilling in these areas.

A study of 113 wells drilled in the Denver-Julesburg Basin showed that actual savings on contract footage was approximately $100,000. These wells averaged 5500 ft in depth and most of the drilling was done with soft formation bits. The last bit used in each well was a medium-hard bit.

Slimhole drilling in Canada has been in a combination of soft, medium-hard and hard formations. Experience on 20 slim holes indicates penetration rates are approximately the same as with conventional holes. However, feet per bit drilled was 35% less for slim holes than was achieved in conventional sizes. Nevertheless, contractors have concluded there are other economic advantages in slimhole drilling that offset the increased costs caused by higher bit consumption. Light rigs and light drill strings play a much more important part where roads and locations are a major cost.

Definition of the terms "soft drilling" and "hard drilling" varies in different areas. In the western half of Texas and eastern half of New Mexico, the Permian beds vary from soft to medium-soft in the redbeds, salt and anhydrite sections; these beds vary from medium-hard to hard in the dense dolomites and sands. Pennsylvanian beds should be classified as medium-hard to hard and the pre-Pennsylvanian beds as hard to very hard. This discussion deals

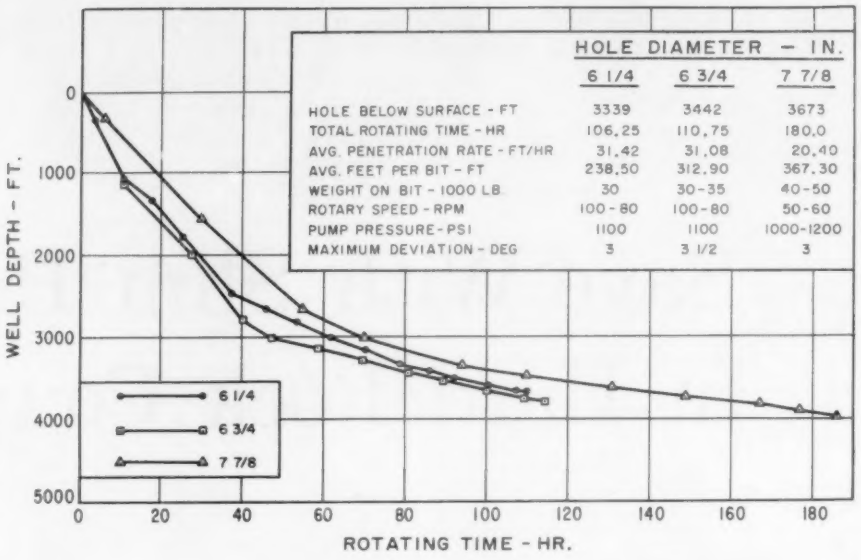


Fig. 1. Typical bit records for 6¼, 6¾, and 7⅞-in. holes show superior performance of smaller bits in hard rock. Information in the inset applies to that part of each hole drilled below the surface hole.

with the drilling expected in the medium-hard to hard Pennsylvanian beds.

Slim Holes in Hard Rock

A study was made of 48 wells drilled in a square of adjoining sections in an area lying between Eunice and Jal, N. M. Of these 48 wells, 15 were not considered because of some practice or condition encountered which made the well irregular, such as an excessive amount of coring. All wells considered were drilled in the Permian section with the first medium-hard bit run as the second or third bit under the surface. The average well required from 10 to 14 bits. The hardest rock bit used was a Hughes W7J or equivalent. All wells were drilled with a jet bit program and the drilling fluid used was water or natural mud with very little commercial mud added.

The summary of this study is shown in Table 1, which gives average rate of penetration, feet per bit drilled and bit cost per foot. Rate of penetration for slim holes was greater than for the 7⅞-in. holes. Feet drilled per bit for the 6¾-in. hole was very close to that achieved with the 7⅞-in. bit. Bit cost per foot with the 6¾-in. bit is 4¢ less than that with the 7⅞-in. bit. The 6¼-in. bit had a slightly higher penetration rate than the 6¾ or 7⅞-in. bit, but feet per bit was 28% less than the 6¾-in. bit and 33% less than the 7⅞-in. bit, resulting in a 30% higher bit cost for the 6¼-in. bit over the 6¾-in. bit.

An actual bit record for each size hole is shown in Fig. 1.

On the first hole drilled, total rotating hours was 154. On the next well, total rotating hours was 123; the next, 115; the next, 109; and then 105. It is apparent from these results that mastering the technique of drilling with smaller bits is the key to economical operation.

Contrary to the generally accepted opinion, it was found that the bearings were not the weakest point in design of the 6¼-in. bit; the limiting factor was dulling of the teeth. We found high rates of penetration when the bits were fresh, but the rate dropped rapidly as the bit dulled. With a medium-hard to hard bit, the average run was cut from 12 to 8 hr. While running from 4000 to 4500 lb per inch of bit with rotary speeds from 60 to 100 rpm, bearing damage was rare.

In drilling salt and anhydrite sections, we found that not only were rates of penetration good but the feet drilled per bit approached that achieved with a 6¾-in. bit.

In subsequent drilling we plan longer bit runs in soft to medium-soft formations. The only green bits pulled were in soft sections. A good penetration rate was achieved in medium-hard to hard formations but no real progress was made in increasing the feet drilled per bit. However, if the rate of penetration decreased, we did not get an increase in feet drilled per bit.

Bit Performance

As indicated in Table 1, there is a radical difference in feet drilled per bit between the 6¼ and 6¾-in. bits, but little or no difference

Table 1. Slimhole Drilling Southeast New Mexico.

Hole Size -in.	Number of Wells Considered	Average Rate of Penetration -ft/hr	Average Bit Performance -ft/bit	Average bit Cost -$/bit
6¼	9	29.7	245	0.617
6¾	12	28.4	344	0.475
7⅞	12	24.9	370	0.513

between the 6¾ and 7⅞-in. bits. Why the difference? Bearing failures have not been excessive. Weight in lb per inch of bit was approximately the same for all bits. Tooth design on the same type of bit is practically identical, although tooth depth on a typical 7⅞-in. bit is ½ in.; on a 6¾-in. bit, ⅜ in.; and on a 6¼-in. bit, 11/32 in.

There is one principal difference between the 6¼ and 6¾-in. bits made by one major bit manufacturer: there is one less row of teeth on the 6¼-in. bit. This means that there is 25% less steel on bottom, yet only 17% less hole to cut. This is the only logical reason to account for the difference in feet drilled per bit.

It appears that application of the variable weight and rotary speed technique could result in improved feet-per-bit performance. This technique involves using relatively light weight and high speeds with a new bit and, as the bit wears, increasing weight on the bit while decreasing the rotary speed.

Another factor observed in slimhole drilling in hard rock is the tendency of the small bore to leave the vertical and the difficulty of correcting it. It was found in drilling the 6¼-in. hole that this problem could be alleviated by running two 5½-in. OD collars on bottom and using a rotating type stabilizer one collar off bottom.

The typical drill string consisted of 2⅞-in. OD, 6.5 lb, N-80 tubing, with 4⅛-in. OD, 2⅞-in. IF tool joints screwed on the tubing with twenty-two 5¼-in. OD, 2¼-in. ID drill collars. We are now running 15 to 20 joints of 3½-in. or 4½-in. OD drill pipe immediately above the drill collars to avoid the possibility of fatigue cracks in the drill tubing and to stiffen the assembly immediately above the drill collars.

Selection of the proper drill string is essential to accomplish the economy sought for in slimhole drilling. Thin-wall drill pipe or drill tubing is the key to reducing costs in hydraulics. Light drill strings reduce costs in initial outlay and operation of drawworks. There is substantial progress being made in the design of light drill strings, such as the new seamless dual weight pipe.

Slimhole Rigs

The rigs our company uses for slimhole drilling are light, mobile rigs with nearly all components on wheels and, in some cases, they hardly resemble the usual concept of a drilling rig. In may cases, the drilling contractor has yet to come to a full realization that, even though there is romance in big engines and big derricks, there are no proportionate big profits.

With the use of proper rigs to match horsepower and hydraulic requirements, the drilling contractor can more economically drill slim holes than conventional holes. This economy applies not only to drilling in soft formations but also in medium-hard to hard formations, including the Permian and Pennsylvanian sections in West Texas and East New Mexico.

Trends in production practices, such as running 4½-in. casing in a 6¼-in. hole, indicate an increasing demand for slimhole drilling in all types of formations. As the demand increases, equipment and drilling techniques will steadily improve to meet this challenge economically.

The current economic condition in the drilling industry leaves little or no room for experimental work on the part of the contractor. He is shackled with drilling prices that do not permit him to operate a sound and aggressive company that is capable of developing new techniques and better processes. However, when drilling prices become more realistic, the economics of slimhole drilling will be of more significance.

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■

How to Interpret

Oscilloscope photos of acoustic logging signals taken recently by Pan Geo Atlas Corp. at a well in the Quarantine Bay area of Southeast Louisiana reflect good, bad and indifferent casing cement jobs.

These photos, along with many others, serve to illustrate the importance of the single-receiver velocity curve when recorded with the amplitude curve for interpreting Sata acoustic cement logs.

Unbonded Sections

The first picture, Fig. 1, was taken under conditions where there was no bond observed or expected, for no attempt had been made to place cement behind the casing at this point.

Notice that amplitude of the signal is extremely high, and time of the signal is representative of velocity of the casing (57 microseconds per ft or 17,500 ft per sec). Typical rate of attenuation of a sound wave in steel is clearly shown by length of time required for the oscilloscope trace to return to an almost zero position.

Both traces on the scope are presentations of the same downhole signal. Top trace is taken from a point in the amplitude measuring circuit and lower trace is from the timing system. Tracking pulse on the upper signal marks point at which the amplitude is being measured, while tracking pulse on the lower trace shows where time is being "picked."

Sync pulse at left side of scope is the instant at which the acoustic transmitter makes the sound energy. Time increases to the right in accordance with the scale shown on the scope.

Longer pointer (labeled "noise gate") on each trace marks the time at which a gate in the circuit opens. Before this time no measurement can be made. This gate is set well in front of any expected signals; for example, 33 micro-

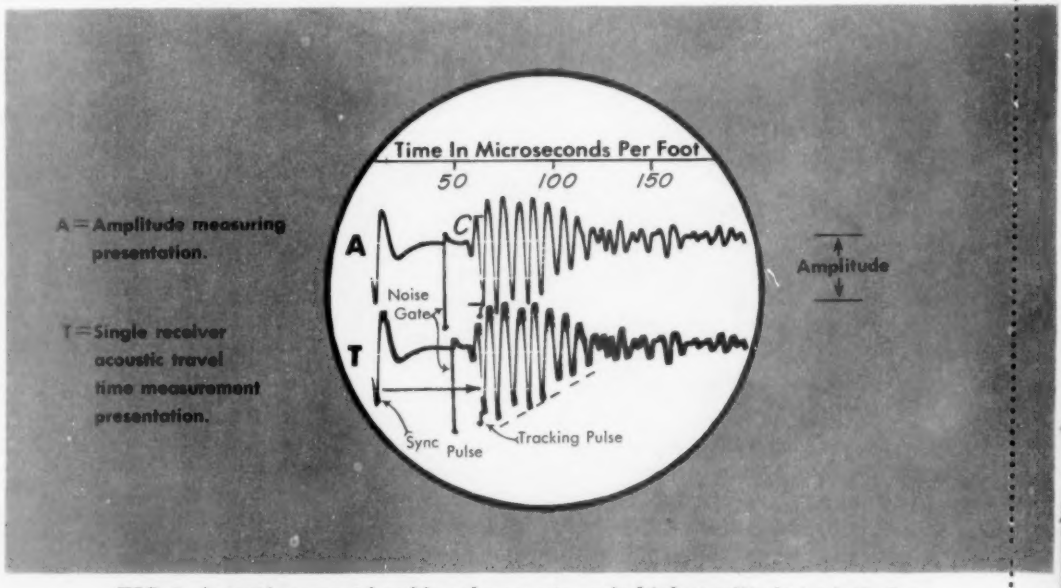

FIG. 1. Acoustic cement bond log shows extremely high amplitude typical of unbonded sections. Time of the signal approaches the velocity of sound in casing.

by C. H. Thurber, E. G. Crow and B. F. Latson

Acoustic Cement Bond Logs

seconds per ft or 30,000 ft per sec. Its purpose is to reduce chances of the tracking pulse jumping into random noises which occur at some time between transmission and reception of the desired signal. No noise of this type is shown on any of the examples and it is extremely rare in present-day equipment.

Poor Cement Bond

Fig. 2 is typical of a zone that should show some cement bond. Amplitude of the casing signal is much lower than in Fig. 1, but is still strong enough to indicate the casing is able to ring. Coming to the receiver, at some later time, is a formation signal shown at F. This proves some sound is being refracted through the formation and back to the receiver. Based on present data, it is believed this can be done only when all the interfaces are well coupled.

A formation signal can be received only when casing, cement and formation are well coupled. This is borne out by the fact that a strong formation signal is seen in well-bonded zones (low casing amplitude signal) and is not seen at all, or only slightly, at much longer times in zones that are known to be uncemented.

Note that there is no formation response on the oscilloscope in Fig. 1. Fig. 2 is bonded better than Fig. 1, but not as well as Fig. 3. At this time, it is not possible to say whether or not Fig. 2 is bonded sufficiently for complete isolation; but if this condition existed over a very long area, the cement job would be considered poor.

Good Bond

In Fig. 3, it is possible to see only a very small casing signal. Most of the sound energy is being refracted through the formation, as shown by the stronger formation signal. When

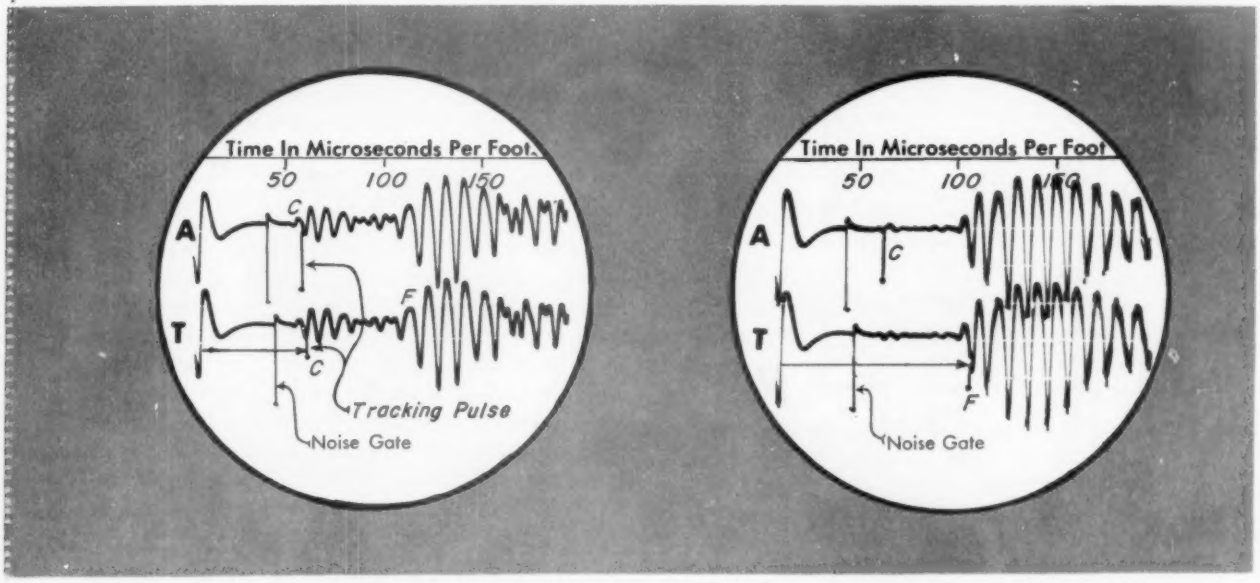

FIG. 2. Poor bond is reflected in this trace of low-amplitude casing signal followed by a later formation signal at F.

FIG. 3. Very small casing signal followed by a strong formation signal indicates a good cement bond to the casing and to the formation.

a signal like this is received, there is little doubt of the bonding quality. It is exceptionally good.

Interpretation of acoustic cement logs, therefore, becomes clear-cut. Fig. 1 can be said to be unbonded, while Fig. 3 is unmistakenly well cemented. Some intermediate condition is illustrated in Fig. 2. Study of the open hole logs is necessary in every case to determine whether or not a cement squeeze will aid in producing water-free hydrocarbons.

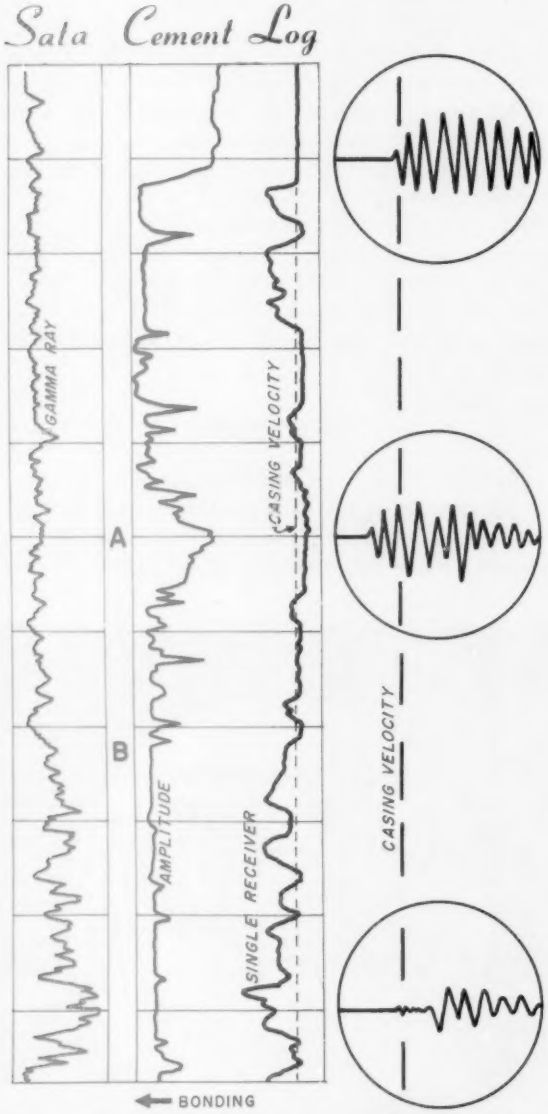

FIG. 4. Typical acoustic log from a West Texas well indicates importance of a single-receiver velocity curve in interpreting certain problem zones.

One condition not shown in the preceding examples is that of a formation signal arriving at the receiver before the casing signal, in which case the amplitude of the casing signal is overridden. Obviously, it is necessary to know if the system is measuring amplitude of the casing signal or of the formation signal, or perhaps even of a cement signal. It is important to be certain which signal amplitude is being measured.

To determine just which amplitude is being recorded, a large scope presentation in the logging unit is essential, and log interpretation becomes impossible without a recording of this scope signal or a single-receiver time curve. Formation signal is a problem only when the velocities are high.

Complete Log

Fig. 4 shows an acoustic cement log made in the high-velocity environment of West Texas. Without the single-receiver velocity curve, Zone A would be interpreted as poorly bonded. However, the single-receiver velocity curve shows the amplitude recorded was that of the formation and not of the casing because the velocity is greater than that of the casing velocity. The stronger signal, as shown by the amplitude curve, was caused simply by a limestone or dolomite which transmitted the signal at a higher energy level.

From B down, the section is predominantly more shaly and the single-receiver curve logged a signal arriving at the receiver after the casing signal, as shown in Fig. 3. At A, the formation signal is reaching the receiver before the casing energy. Above the top of the cement the sound carried by the casing is very strong and both curves are recording it, as shown in Fig. 1. If the single receiver had recorded casing velocity at Zone A, the interpretation would have been poor bond.

Necessity of a single-receiver travel time curve or a permanent recording of the monitoring scope on film is emphasized. Without one or the other, an amplitude curve may very well be questionable, leading to unnecessary squeeze jobs. Recording the single-receiver time curve simultaneously with the amplitude curve provides means for less confusing acoustic cement log interpretation. This will undoubtedly result in better cementing techniques and more reliable formation testing at less cost.

C. H. Thurber is manager of the acoustic logging department; E. G. Crow and B. F. Latson are acoustic engineers with Pan Geo Atlas Corp., Houston.

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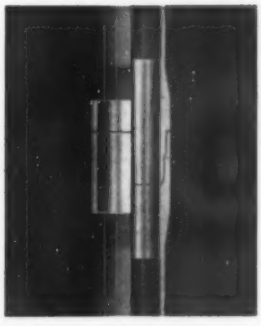

Talk with operators who've had experience with them. An operator who has just brought in a quadruple completion—four independent strings to pay zones between 9,000 and 10,000 feet—using 2⅜" Hydril "CS" Tubing Joints in 9⅝" casing, says. "The Hydril 'CS' Joint is an easy joint to run. With its two-step thread, it makes up fast. It's pressure-tight when made up and you can depend on it to stay that way."

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Tools for Perforating Casing

by F. O. Bohn

To provide the most useful path for flow of fluids into or from a cased borehole, the engineer has a wealth of perforating equipment available.

Casing perforators fall into two general types — bullet perforators and shaped charge jet perforators. The variety of well completions made today has led to development of a corresponding variety of modifications of the two basic perforators.

From the standpoint of perforating, there are only two basic types of well completions — conventional (where the production casing or some special combination thereof is set continuously from the surface down to and through the zone or zones of interest) and through-tubing.

Included under through-tubing is the specialized case where accessories are included in the tubing for use in the permanent well completion technique. In this completion technique, the tubing is run in the production casing and completely flanged up before the well is perforated.

As a general rule, conventional completions utilize both bullet and the shaped charge perforators in all applications. Only when a conventional completion involves small diameter casing, as in the tubingless completion, are there size restrictions which may cause preference for the shaped charge guns.

Almost without exception, the through-tubing type of completion calls for the use of the shaped charge gun because of severe limitations on gun diameter.

Bullet Gun Perforators

Bullet perforators have appeared in two general types. One is a "chamber" type gun where the components of a gun are contained in a single-shot cylindrical chamber. The chamber had means for rapid and easy installation in a ported carrier. However, because of the inefficient use of space within the envelope given to a particular gun size, and because of the wide spacing between gun barrels, this design has not been used much in the past ten years. It is, however, economical in operation.

Current gun designs are often called bar stock guns. The ballistic design features of each port, or gun, are machined in the bar. This provides for the most effective use of the steel within the gun envelope. Closer spacing of the individual gun barrels is also possible. The result has been higher performance and more shots per gun or run.

Fig. 1 is a cross-section typical of bullet guns, but not representative of a brand, nor can it be scaled. The essential parts of a bullet gun are represented by the barrel, the bullet, the propellant powder in a cartridge tube that fits in the combustion chamber, and the igniter.

Parts peculiar to a well perforating gun are the seals to exclude fluids under high pressure and the type of igniter. Whereas most guns in common usage have percussion igniters, well perforators usually have an electrically fired igniter. In this figure the igniter is shown in the combustion chamber. This is typical of selectively fired guns, in which each shot is fired individually.

The performance of a gun perforator cannot be tied to any one design feature. We often hear performance described as being a function of the amount of powder used. Although they might not be as attractive, the other features might just as well be used: that is, barrel length; the bullet length, diameter and weight; the combustion chamber volume; and the loading density of the powder. Any one of these values might be larger than that found in competitive

The importance of Simplicity in a retrievable squeeze packer

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THE BAKER SERVICEMEN who run the Full-Bore Cementer have two important things working with them and for you. They have professional skill in running Baker service tools, and in the Full-Bore they have a superior tool to run. The combination offers a dependability that's hard to equal.

BAKER FULL-BORE CEMENTER

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Facts about a reliable squeeze tool

1 It is an important squeeze cementing tool. (Full Bore makes reversing out sand bridges easy; and allows re-perforation, when necessary, without a round trip with tubing.)

2 Ability to hold pressure from above or below makes it ideal for testing casing.

3 Optional Baker Model N Full-Bore Tubing Tester permits testing of tubing string in conjunction with operation of the Cementer.

4 The Cementer is an important tool for formation fracturing and high pressure acidizing. (Full Bore helps prevent sand screen-out when fracturing. On completion of frac or acidizing operation, tubing may be swabbed immediately, without having to reset the Cementer. When pressure reverses, opposite set of slips takes over automatically. Packing elements stay packed off, resist pressure from either direction.)

5 It is teamed with the Baker Retrievable Bridge Plug in straddle operations—either single-zone or selective multiple-zone. Together they can straddle a virtually unlimited interval. And: because both Cementer and Plug are so easy to pick up and relocate, any number of zones can be tested and treated in one round trip.

6 An unloader allows circulation above the Cementer, or equalization of tubing-annulus pressures, when desired.

7 The packer retrieves simply and easily. For added protection, two emergency release mechanisms are built-in.

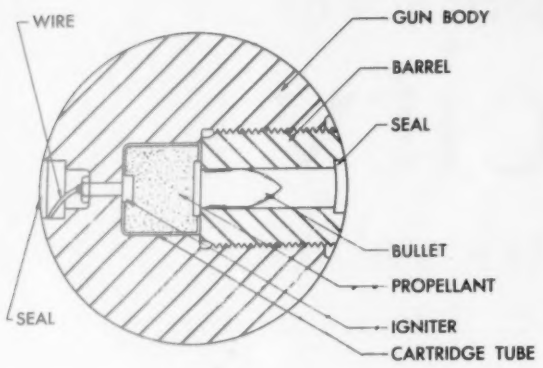
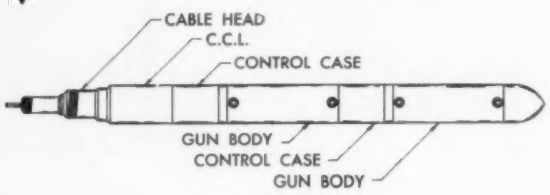


FIG. 1. Typical bullet perforator uses a projectile fired by a contained charge to perforate casing and the formation.

FIG. 2. Assembled bullet perforator gun incorporates a casing collar locator which permits accurate placement of perforations in the selected zone.



guns and still not permit a good evaluation. In other words, the performance of a gun perforator is dependent upon an optimum balance of the components. The only real comparison is in results obtained.

The environment in perforating operations has other influential factors besides permitting use of a small safety factor. A fluid is often involved, and as the gun is run deeper, pressure and temperature rise. Effect of fluid pressure is not really important in bullet perforators. Since they are designed to contain very high internal pressures, external pressure is not important, even as an assist.

The only exception is in the muzzle seal. This seal keeps fluid off the bullet and out of the combustion chamber. In the past there have been perforators which used well fluid pressure to hold back the bullet until the gas pressure build-up had been properly started. Performance of a gun is, to a degree, dependent upon this bullet holdback. Consequently, current designs use some type of controlled hold-back to get optimum gas pressure build-up for other design features.

Most of the bullet perforators use an igniter in each powder compartment. This system permits complete isolation of every gun port in the gun body. This simplifies some of the ballistic problems, but complicates the gun assembly. The greatest benefit comes from ability to fire gun ports in banks of a few ports to the ultimate in flexibility, one port at a time. With these degrees of flexibility, perforations can be made at various spacings — spacings less than and more than that of the gun body. The net result is efficiency in terms of the number of runs required to produce perforating patterns differing from that of the gun.

Where individual igniters are not used for each port, a master igniter is used for all ports or banks of ports in a gun. Ignition of the individual ports within a bank or gun is usually done with a flame passage or train. One other system involves shock detonation by explosive cords. Because of dependability of modern explosive cords, the latter could be quite consistent in initiation.

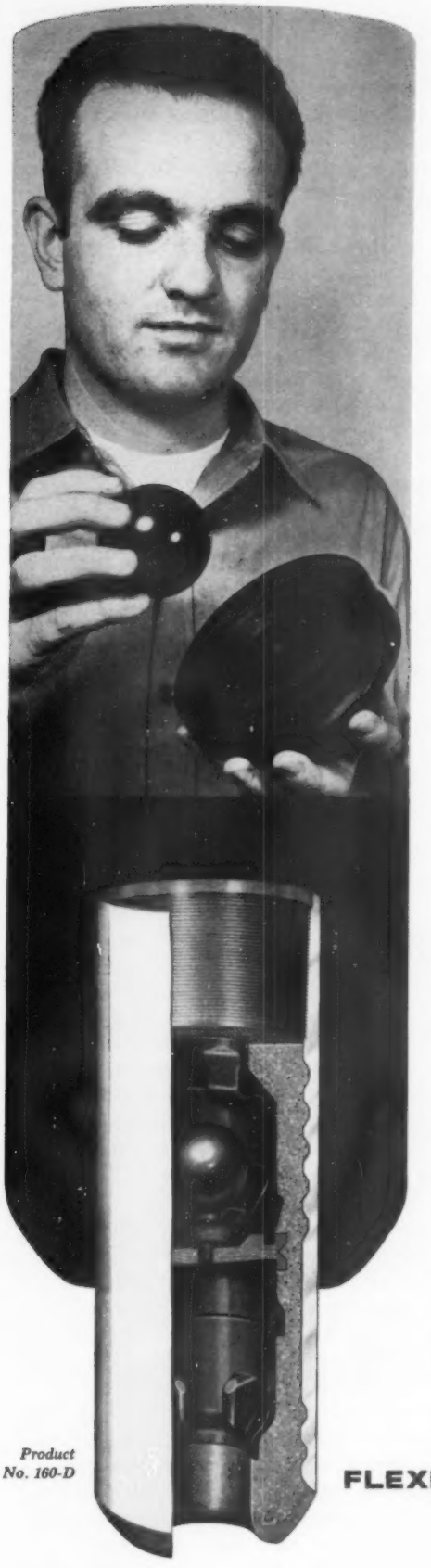
Assembly of gun bodies for runs into a well usually involves accessories such as cableheads for connections to the conductor cable, calibrated release mechanisms for safety and control apparatus for one or more guns. These accessories and their relative position are shown in Fig. 2.

A really important accessory is the casing collar locator. It is key to accurate placement of perforations in the selective zone. Collars are used as bench marks in the correlation of depth measurements from the open hole log to the perforating run through use of a radioactivity and collar log.

High downhole pressures impose practically no limitations for bullet perforators. Fluid seals used at the barrel muzzle and other openings are the limiting parts, and such seals are easily built to stand 30,000 psi or more.

Temperature may be a different situation. In general, propellant powders have temperature limitations more restrictive than the hydrostatic head. Although there are only a few commercial powders available to the industry, there may be a number of blends, or other modifications. Among the commercial powders, there are powders which are called standard and high temperature. There are also special powders which are supposed to have higher temperature ratings than the commercial varieties. Without specific data on all the propellant powders used by the service companies, it is impossible to give specific data on operational temperatures.

The temperature at which a powder can



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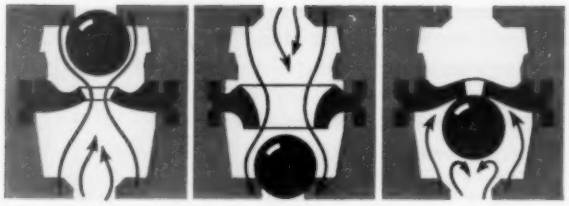

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"hold" without spontaneous combustion for 24 hours has been used as the safe limit. Above that, temperature operations should be conducted on basis of time and reduced safety factor permissible. When there are reasons for using a bullet perforator at higher temperatures, or any perforator for that matter, safe operating temperatures can be obtained and evaluated with help of the service companies.

Another environmental factor which should be considered is type of fluid in the perforating operation. This factor is common to all perforators and will be covered later.

What are applications for the bullet perforator? If we included the modifications of standard equipment and the one-time tries at solving unique problems, the list would be long. The usual applications can be grouped into a few examples—original and recompletions, remedial work and preparation for other well services.

Much work of bullet perforators has been in opening zones passed up for more prolific and deeper zones. The radioactivity log has contributed much to this application by making it possible to discover and locate such zones.

Original completion would be a singular application only when the productive portion of the formation has been accurately defined, the cement job has been proved effective and the perforations have been properly placed. Any failure in these processes will usually call for remedial work, which is greatly dependent upon additional perforating.

Oftentimes prudence and/or local regulations call for checks on completion procedures. These checks involve perforations to test the effectiveness of the cement job. They may involve several levels, depending upon the information required or desired. When negative results are obtained, the recementing may require additional perforations placed to provide annulus circulation and/or spotting of the corrective cement squeeze job.

Some uses are more correctly placed in the category of remedial work. Often the variety and extent of work performed causes us to think of it as a recompletion.

Perforating for remedial work provides a means for:

1. Eliminating channels from and to water or gas.
2. Eliminating water production due to coning or a rising water table.
3. Reducing gas/oil ratios.
4. Increasing gas flow for gas lift.
5. Counteracting loss in productivity because of reduced permeability around old perforations or reservoir characteristics.

Some remedial work becomes necessary so early in the life of the well that it may become a part of the completion in subsequently drilled wells. Among these applications for the perforator are placement of sand consolidating materials and placement of sand and gravel packs.

Perforating is a distinct aid in the selective injection of fluids for stimulation and secondary recovery. Acidizing and fracturing patterns can often be directed to best effect through carefully placed perforations with the use of aids, such as ball and chemical sealers.

Cost and flexibility are the main attributes of the bullet perforator. These characteristics may be used to advantage in soft to unconsolidated sands where penetration of the bullet perforators is comparable to that of shaped charges. It is in the medium to hard formations where depth of penetration gives superiority to the shaped charge. If the hard formation requires some kind of treatment for commercial production, it still may be advantageous to use the bullet perforator. Recent testing in very hard formations indicates more equality of performance between bullet and shaped charges than previously suspected.

All the suggested applications are limited to the conventional completion due to size of the production string. Disregarding costs, the bullet perforator is competitive to shaped charges only in casing sizes above 4½ to 5-in. OD. Bullet guns with outside diameters below 3 in. have not been able to perform as well as the shaped charge guns of comparable size.

Shaped Charge Perforators

Use of the shaped charges in well perforators grew out of developments just prior to and during World War II. When these developments were made available to industry, there still was a lot of work required to adapt the shaped charge to oilwell perforators. Container size and shape had to be quite different because of the tremendous difference in environment. The configuration and characteristics of the components vary with the intended use, even within the one application to well perforators.

The common description of a lined cavity shaped charge is shown in Fig. 3. As the detonation wave progresses from the initiation point, it progressively encounters the cavity and the liner. A collapsing and progressive disintegration occurs with the wave front. Very fine particles are carried into the condensing wave to form a particle-laden stream, commonly called the jet. A portion of the most common liners is not disintegrated and follows behind the faster jet stream as a relatively slow moving slug or carrot. The perforation is made by the particle-laden jet stream much in the same

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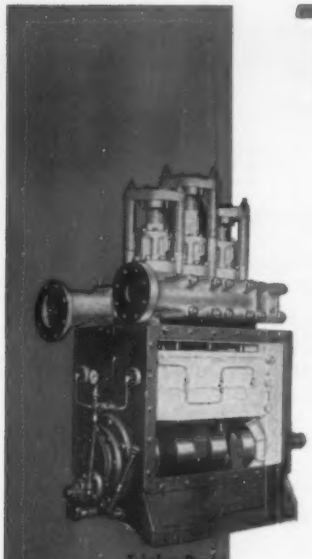
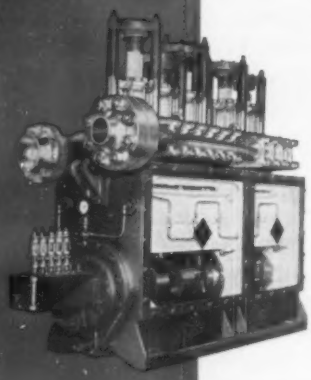
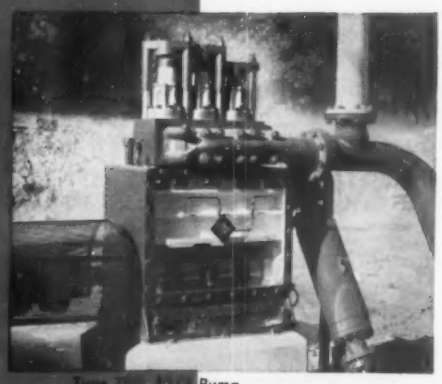


Triplex Pump



Quintuplex Pump



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way that a particle-laden stream of high pressure fluid will jet a hole in some materials.

Nature of the perforation depends upon the design and the materials used in the shaped charge. Any one design feature may be altered and some change will be noted in results obtained. As in the ballistic features of a bullet gun perforator, it is unwise to judge capabilities of a shaped charge by comparing any one feature, such as explosive weight, liner material or configuration.

Again referring to Fig. 3, the common points of interest in a shaped charge are the case; cap or lid; explosive; liner; means of detonation and standoff.

It is safe to say the liner is the most important part affecting performance of the shaped charge. There are as many designs as the combined total of types, sizes and brands. Most are made of stamped copper because of that metal's physical characteristics.

One well-known disadvantage of stamped copper is its inherent tendency to form undesirably large slugs or carrots when optimum performance is obtained. When large slugs are deposited in perforations, the productivity is reduced, sometimes to the point of ineffectiveness. Elimination of the slug has been one of the major accomplishments in charge development.

Detonation of individual charges is almost identical in all types of guns. The detonating force is brought to each charge by a detonation cord, commonly called primacord. It is merely a fuse-like train of high explosive having sufficient power to detonate the shaped charge. Covering around the explosive is varied to suit conditions under which it is used. In hollow carrier guns, where the cord is in air, the covering is just a container. The cord used with capsule-type guns has a cover to exclude well fluids.

Speed of the detonation wave in the cord is important in its effect on charge spacing. The faster the speed of detonation the closer the charges can be spaced in a gun assembly. Because of the very limited number of cords available, interference and other effects resulting from the characteristics of the primacord has been mitigated by gun design.

One design feature of shaped charges which does not directly involve a component is often misunderstood. We refer to "standoff." It is often used incorrectly to designate clearance between the gun and the casing. Standoff is built into the gun assembly whether it be a charge in a hollow carrier or an individually encapsulated charge. By common usage among developers of shaped charges, standoff is distance from base of the liner to the first target or resistance. In oil wells where charges must

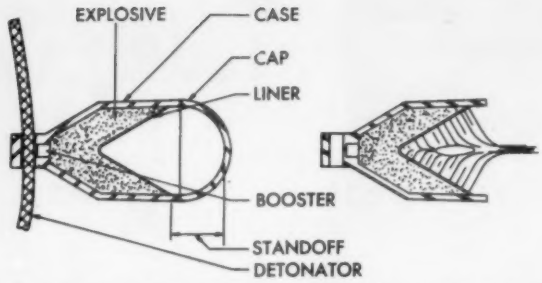


FIG. 3. Typical shaped charge creates a particle-laden jet stream which perforates casing and formation. Slower-moving slug of undisintegrated particles is produced by the most common charges.

be protected from fluids, the port plug or the lid of an encapsulated charge is the first target. Standoff is an influential design feature in the performance of a charge, and as in the other design features, it is fixed.

Gun clearance is more important in field operations and field evaluation. It is distance from outside of the gun assembly to inside of the casing. In a given gun in a given casing, this will, of course, vary according to the way the gun positions itself. For evaluating performance, gun clearance is considered at standard distances of zero inches, one-half inch and the maximum for the gun in the largest casing recommended for the gun. Because of the effects of long fluid paths to the casing, shaped charge guns should be carefully evaluated from the standpoint of gun clearance.

Hollow Carrier Guns

Hollow carrier guns have features which are very desirable and not found in the other types. Fig. 4 is a section of a typical hollow carrier gun.

Important features are strength of the gun body and manner in which the fluid is excluded. The heavy section in the gun body is ideal for withstanding any fluid pressure we now have or anticipate in the future. The type of fluid seal through which each charge must shoot has much the same pressure resistance characteristics and potentialities.

Outstanding operational features are containment of explosive forces and retention of residual parts. Since only a small part of the energy of the explosive is directed to the jet stream, forces radiating from the charge inside the carrier are considerable. Due to configuration of charge and case, the stray forces are somewhat concentrated.

This results in swelling of hollow carrier guns. Swelling of the gun body in localized spots opposite the flank of the charge is the con-

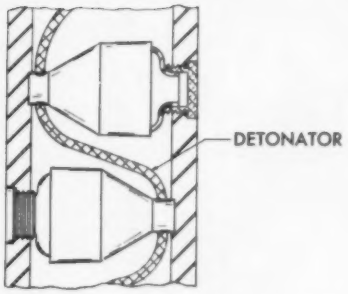


FIG. 4. Casing type shaped charge gun incorporates the charges in a heavy carrier which protects charges from fluid pressures, contains explosive forces, and retains debris from charges.

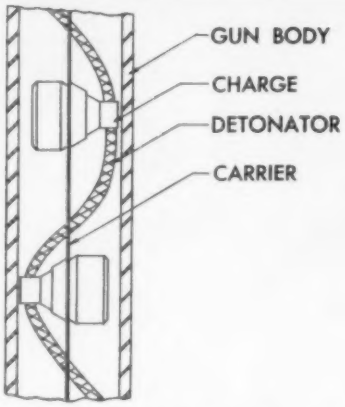


FIG. 5. Expendable retrievable type shaped charge gun, designed for slimhole perforating, has a thin-walled carrier which is not reuseable.

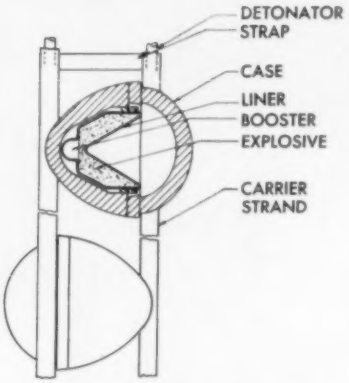


FIG. 6. Open hole type gun encapsulates individual charges in cases which are supported by carrier strands. This gun leaves little or no debris in the hole.

trolling factor in gun life. Although gun life will eventually be ended by cracks in the swelled areas, it is usually limited by excessive gun diameter. Distortion of the gun body indicates a measure of the stress the casing does not have to withstand.

The other outstanding feature is debris retention in the gun body. Debris from charge cases and charge holding accessories may be objectionable in the well and particularly in the perforation. Although some part of such debris may be carried by the jet into the perforation the effects of debris are mainly those of junk in the well. The hollow carrier is the most effective gun in the lessening of this problem.

Other desirable features include some flexibility in shot density; some choice of performance characteristics, as measured by hole size; penetration and productivity under specified conditions. Hollow carrier guns are made in sections of various lengths and can be joined together to increase the number of perforations obtained in each run.

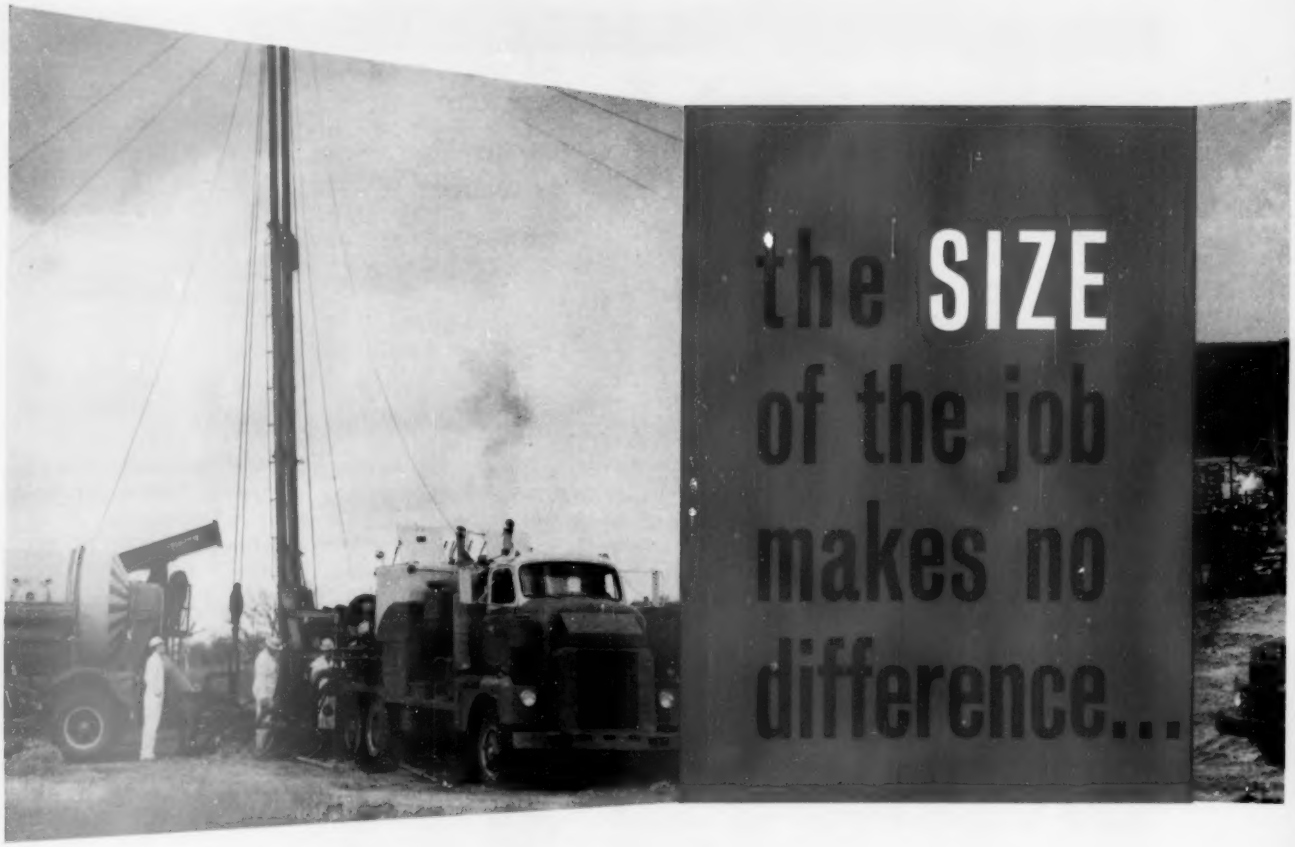
Assembly of guns and accessories is much the same as described for the bullet perforator, particularly where a control apparatus permits some selectivity. The most important accessory in the assembly is the casing collar locator. Its use in depth correlation with electric and radioactivity logs is the same as described for the bullet perforator, particularly where a control apparatus permits some selectivity.

Pressures encountered in present day well completions are no problem for these guns. To keep up with pressures in the foreseeable future, the industry needs only to increase the bulkhead strength in the port fluid seals. This will be true as long as casing sizes permit use of the current gun sizes. Heavy-walled hollow carrier guns are available in 3 or 3⅛, 3⅝, 4 and 5-in. OD.

These guns are usually used where the well fluid is a drilling fluid and the pressure is greater than anticipated formation pressure. Under these conditions, effectiveness depends upon productivity of the perforations obtained and type of fluid in the hole. As in the case of bullet perforators, effectiveness can be increased by changing the fluid in the hole or spotting a compatible fluid in the shooting zone. The objective is to eliminate, or at least reduce the effects of damaging filtrate and filter cakes in the perforations.

Although hollow carrier guns have higher temperature limitations than any other type of shaped charge perforator, there are factors which should be considered in high temperature operations. The common but not entirely correct expression of temperature limitations of shaped charge guns is a reference to the charge alone. There are variations in the explosive used which do have some effect on the ability of the charge to perform at high temperatures. The standard commercial blasting caps have limitations not equal to the shaped charge.

The common temperature limitation of the standard explosive is set at 350F. Depending upon the time of exposure in this range, the effect varies from a progressive reduction in effectiveness to complete failure in combustion.



Protection of producing zones is vital in any well regardless of depth or complexity. A simple, shallow well receives the same earnest attention as the deeper, more difficult ones when Halliburton cements them.

At your Halliburton Service Center, the same rugged equipment, the same high quality materials, the same skill and experience stand ready to cement your job whether it calls for one small cementing truck or a dozen massive Twin HT-400 Cementing Units.

These Halliburton Materials and Equipment Help Provide Dependable Cementing . . . Regardless of Job Size

A clean well bore is a prerequisite to good cement bonding. Halliburton developed Mud-Flush to do this job. It has proven itself to be unequaled for this purpose. Mud-Flush helps clean fluid and partially dehydrated mud from wells, with little or no disturbance of the filter cake. This is particularly desirable wherever lost circulation is a problem.

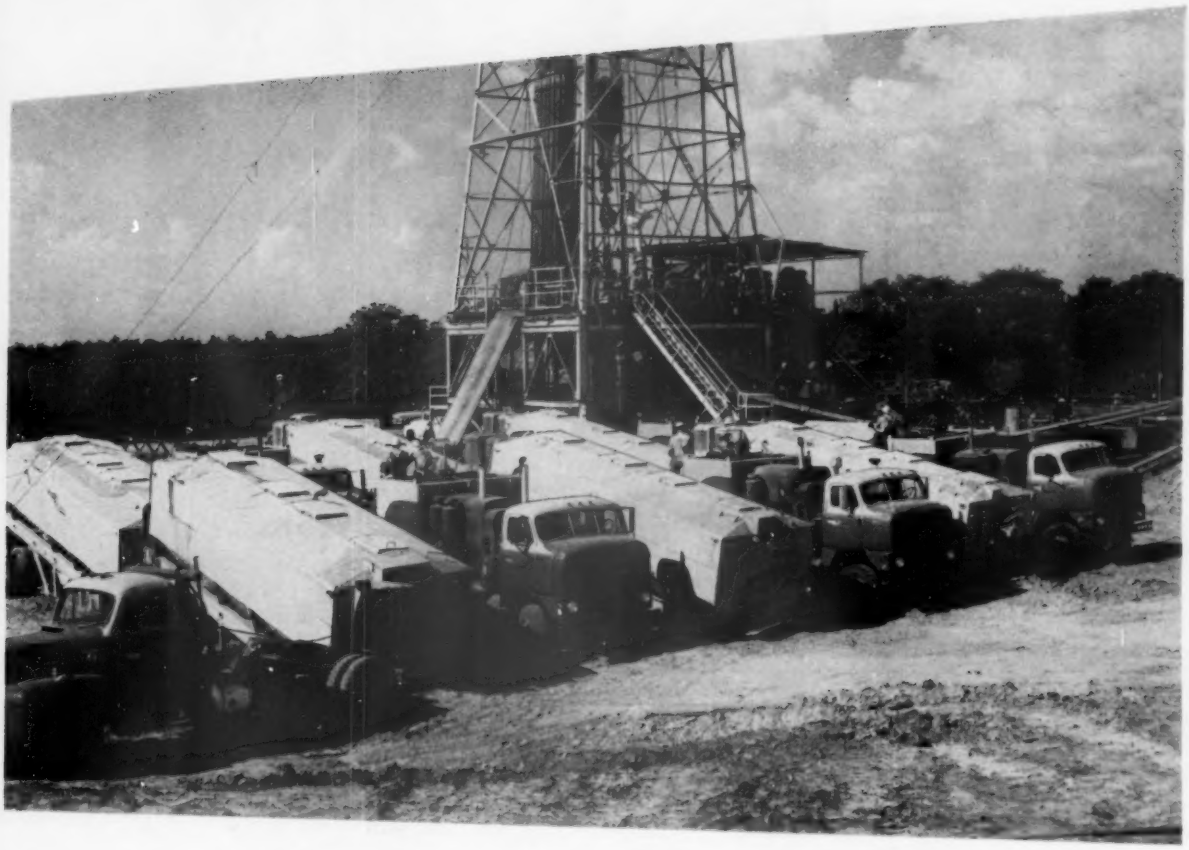
The cleaning action comes from a mud thinner and Morflo II, a Halliburton-developed surfactant, working together to thin and disperse fluid and partially dehydrated mud in the hole.

After cementing, Mud-Flush can be pumped far back into fractured or perforated formations — even highly acid-soluble ones — to disperse clogging mud particles and permit more flow capacity.

The treatment penetrates deeply into most types of permeable formations regardless of acid solubility.

Halliburton Tailors Cement Blends to Your Well Requirements . . .

Lost circulation zones call for lighter weight slurries with bridging agents added to obtain the best fill-up in the annulus for greater strength. Pozmix Cement with Gilsonite is half pozzolanic materials, and half portland cement with Gilsonite added to produce a low-density slurry. Adding volume, not weight, Gilsonite's graded particle size offers superior bridging characteristics for better control of lost circulation. Fill-up of 90% has resulted in many instances with slurry weights ranging from 15.6 lb. per gallon to as low as 10 lb. per gallon. This type cement is resistant to attack from sulphate waters.



FULL-FLOW PACKER SHOE

ROTO WALL CLEANER

CEMENT BASKET

S-3 CASING CENTRALIZER

Big or Small, Your Job Calls for Dependable Tools

Downhole tools play an important role in dependable cementing. Halliburton designs and manufactures these tools to provide better performance. The Formation Packer Shoe, for instance, packs off open hole below the casing for the purpose of helping to protect low pressure formations from cement contamination. Also, it guides and floats the casing string in and allows circulation through the end of the shoe. After the packer is set, cement flows through ports in the side of the shoe, and the Super Seal Back Pressure Valve helps keep the slurry from backing up inside the casing above the tool.

Other Halliburton Tools Aid In The Success of the Cementing Job

Roto Wall Cleaners are used to help remove mud from the bore hole wall to permit a better cement bond and to minimize precautionary or remedial squeeze jobs. Claw-like spring steel fingers dig into the filter cake when the casing is rotated. Since the casing is already in place when rotation begins, there's much less likelihood of sticking the casing out of place.

S-3 Casing Centralizers provide maximum centering force to allow the cement to completely surround the casing for a better bond, and help prevent channeling.

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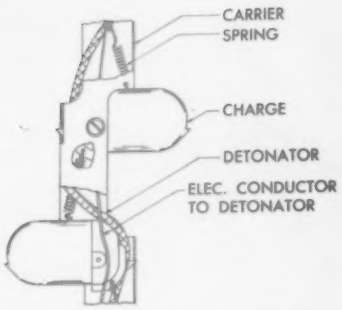


Fig. 7. Swing jet gun is designed to be run through relatively small-diameter tubing. Charges are folded into a carrier and swing into firing position when the gun is located in the hole and fired.

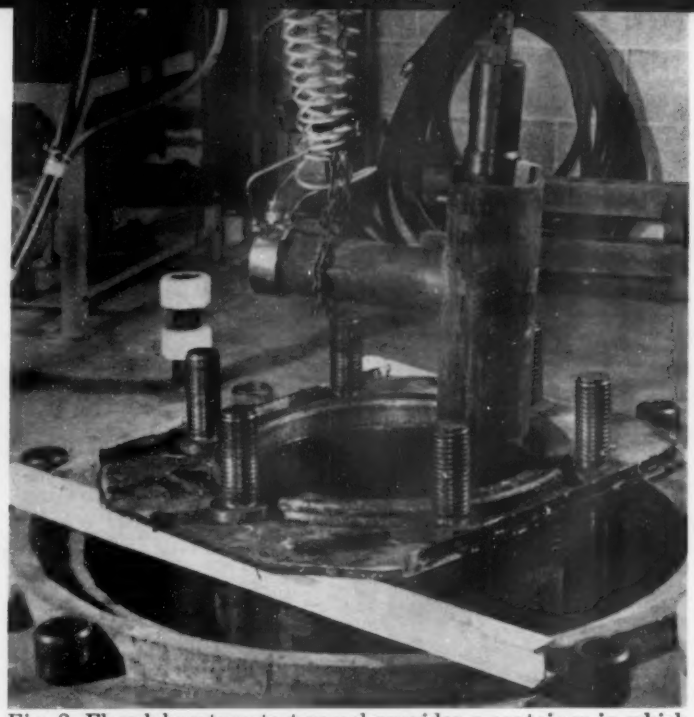


Fig. 8. Flow laboratory test vessel provides a container in which guns can be fired into test targets under simulated reservoir conditions to evaluate gun performance and flow characteristics.

Spontaneous combustion, to our knowledge, has never resulted in jet formation. This is the major advantage of the shaped charge in high temperature operations as long as the limitations of the blasting cap are not exceeded.

Application of hollow carrier shaped charge guns is so much like bullet perforators that details will not be repeated. Initial completion, recompletion and remedial work in conventional completions are the main applications. Special consideration for their use should be given when there are multiple strings of casing or other situations where penetration will be a problem.

Another situation where shaped charges often give better results is where perforations are placed close to water-oil or gas-oil contact. Surface testing has shown less cracking of annulus cement when the shaped charge is used for perforating. This is particularly true when the cement has set to high strengths. Problems of this nature can be eased by careful attention to cementing materials, technique and setting time.

There is a smaller hollow carrier gun which has many of the same features as the larger guns. From the standpoint of application, it can be thought of as a conventional completion tool for the smallest casing or liners. From the standpoint of size and design problems, it is thought of as a through-tubing gun.

Fig. 5 depicts typical features of a small diameter hollow carrier gun. The real difference is in the gun body. In the interest of maximum performance for the size, the gun body walls have been thinned to the point where replaceable fluid seals are impractical. As a result the gun body is expendable because the shaped charge perforates the gun body instead of a fluid seal.

These slim hole guns offer shot densities as high as 4 per ft. Spacing is usually some multiple of 3 in., or in some cases, 4 in. and either unidirectional or at 180 deg orientation. The charges are usually positioned in a carrier which does not lend itself to flexibility in horizontal orientation. A carrier is effective where precise charge orientation is required in a limited number of directions. Standard sizes are 1¾, 1⅞, 2⅛, and 3-in. OD. The 3-in. size is an overlap with the 3⅛-in. heavy-walled gun. As in the large guns of this type, much of the explosive forces from the back and flanks of the charge are absorbed by the gun body, so stress on small diameter casing is a minimum. Temperature limitations are the same as for the large diameter guns using standard components.

Applications follow very closely those of the large hollow carrier guns — original and recompletions, remedial work and preparation for well stimulation. All perforating in the tubingless completion is done under conditions similar to the conventional completions, so use of compatible perforating fluids is very helpful. These guns are used extensively in oriented perforating of multiple tubingless completions.

This is a class of shaped charge guns in which each charge is individually encapsulated in a pressure-resistant material. The most popu-

lar materials have been glass, ceramics and die casting compounds. Die casting materials have included various alloys of zinc and aluminum. The method of assembling the encapsulated charges has varied considerably.

Fig. 6 shows a typical charge in one type of assembly. Well fluid is kept away from the charge and the cavity by the bomb-shaped case and lid. These charges are made in sizes which will run in the ordinary sizes of casing for conventional completion. There is a tendency for these charges to have larger amounts of explosive. When built in the larger sizes and with heavyweight charges, they have been offered as open hole guns.

One good feature is that they leave little or no debris in the hole. The amount of debris depends upon the type of carrier used to make up the gun assembly. Here we show aluminum tubing spaced at the points of an equilateral triangle. Charges are nested within the three tubes. Each tube carries and protects primacord for detonating the charges. In this assembly the charges may be placed unidirectionally, alternating between the legs of a 120-deg angle or in a spiral at 120-deg intervals.

Another carrier form popular with glass and other capsule charges is called the strip gun. Here a flat strip of metal is used for a carrier. The strip has holes into which the charges are inserted and held by clips. The primacord with a well fluid resisting jacket is laced over the back end of the charge. In this type the charge orientation is usually opposed, that is, alternating at 180-deg orientation. It is the most debris-free of all the capsule guns.

It is used in much the same way as hollow carrier guns in conventional completions. Completion, remedial work and preparation for well stimulation are major uses. The largest performance, hole size and penetration are obtained with some models of this type gun. Because of the lack of containment of explosive forces, the casing is subject to greater stress than in the case of hollow carrier guns.

Capsule guns gained their real importance with through-tubing completions. The permanent well completion with accessories in the tubing string is, of course, a specialized through-tubing completion.

One of the early and still quite effective capsule guns is the swing jet shown in Fig. 7. The swing jet overcomes the limitation of tubing diameter. When the gun is in a folded position, charges nest vertically in the carrier. At each end of the charge case is a small lug which interlocks between charges. When all the charges are assembled in the carrier, they may be folded in a progressive sequence from the top. The interlock holds each preceding charge in the vertical position. Only the last or bottom charge must be restrained. It is held in the vertical position by a low order blasting cap bearing against the same lug. Each charge has a spring which forces the charge to revolve into the shooting position.

In the operation, the folded gun is lowered through the tubing. At the shooting zone the first electrical impulse fires the blasting cap which holds the charge in position. Upon release the charges unfold in sequence from the lower end. The last, or top charge, in its movement closes an electrical switch in the circuit to the blasting cap which detonates the primacord and fires all charges. Folding of the charges is a downward motion, so they can be wiped back into running position at re-entry into the tubing.

Swing jet guns are built in two sizes. The outside diameter of the carrier is 1 11/16-in. in the large size. When the large one is in shooting position, it has an effective diameter of 4⅜-in. Gun performance, therefore, is comparable to that of guns run in conventional completions. The smaller gun has a running diameter of 1⅜-in. and unfolds to an effective diameter of 3¼-in. It, of course, has lesser performance but still is quite effective.

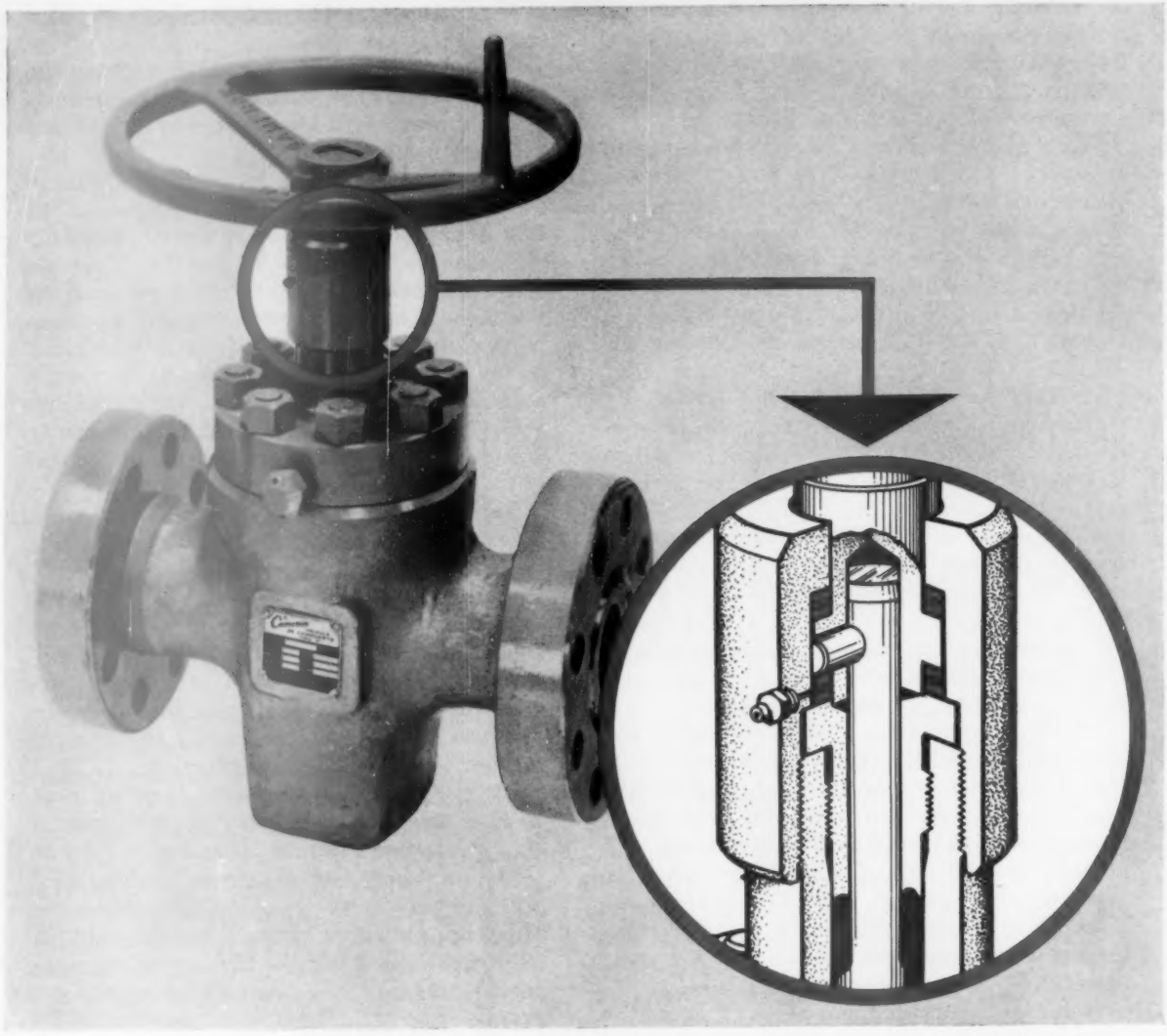
Obviously, these guns have operating problems. However, with proper care in the assembly, handling and running, they can be efficient.

The link-type guns for through-tubing work are another group of capsule-type charges. There are a number of them and the only real difference is in design of the connecting links, or lugs. Again, the case and lid protect the charge from well fluids. Configuration of the parts is similar in most brands evidenced by the great equality of performance. Advantages lie principally in design features which affect service company operations, flexibility, debris characteristics and resistance to pressure. Pressure ratings vary from 10,000 to 15,000 psi with and without reference to temperature. Applications of link-type guns are essentially the same as the swing jet with the addition of those of the tubingless completion.

Testing and Evaluation

As in any other piece of high performance equipment, laboratory testing of perforators is the basis of development and improvement. Ballistics is a science and much design work on internal ballistics can be based on formula and use of impirical data. In bullet perforators this preliminary work can be done, but not with the exactness obtained in long barrel guns.

The shaped charge is not so easily observed with laboratory equipment. Formation and con-



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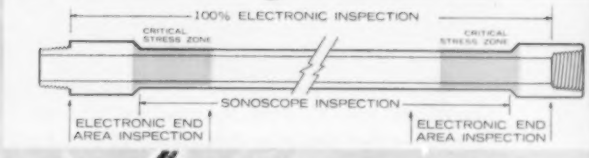

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figuration of the jet stream can be observed with high speed X-ray photography. The equipment, however, is out of reach for most developers. Even when available the results are slow to obtain and often difficult to evaluate. Routine development testing is mostly a procedure of observing results in a suitable target. Mild steel is the most commonly used target. Changes in the configuration and dimensions of the components can be observed by changes in the perforation in mild steel. The real test of the finished product, or the comparison of field equipment is in the targets similar to subsurface formations.

Much of the early demonstration and comparative testing between shaped charges was done in mild steel. Because of the great difference in resistance to penetration, mild steel targets do not accurately compare the shaped charge and the bullet perforators. Besides this, mild steel is not representative of subsurface formations. The better shaped charges used today do not perform as well in mild steel as in some of the early designs. The acquisition of a suitable target for realistic evaluation has been a problem in the industry.

A most important development in laboratory testing is the flow laboratory designed to determine productivity, or flow-index, characteristics of perforations in standard sandstone targets. In this test setup target perforating procedure and measurement of effectiveness are all done under simulated subsurface conditions.

The sandstone is cut to a 39/16-in. OD cylinder. Length varies with the perforator being tested, but must be at least 3 in. longer than depth of penetration. The sandstone core is cemented in a steel cylinder with a cap at one end representing the casing. Between the cap and the core is a ¾-in. thickness of cement. The other end of the steel cylinder is made with threads and a sealing surface to take a cap with fluid flow lines.

Although any core cut with the bedding plane could be used, laboratories have standardized on a Berca sandstone. It is quarried from rather homogenous sections and can be selected for permeability value. It has a compression strength of approximately 5000 psi. Permeability ranges from 10 millidarcys to over 1000. Porosity runs about 18% to 22%. Quarrying and shaping are done so that bedding planes are parallel to the long axis of the core.

Fig. 8 shows one version of a typical flow laboratory test vessel. There are differences in the physical dimensions, but procedures are almost identical. The large cylinder represents the cased hole and takes the gun and target. Different fluids can and have been used in the cylinder to measure their effects on the productivity of perforations. In comparative tests a standard brine solution is used for well bore fluid to eliminate effects of a damaging fluid.

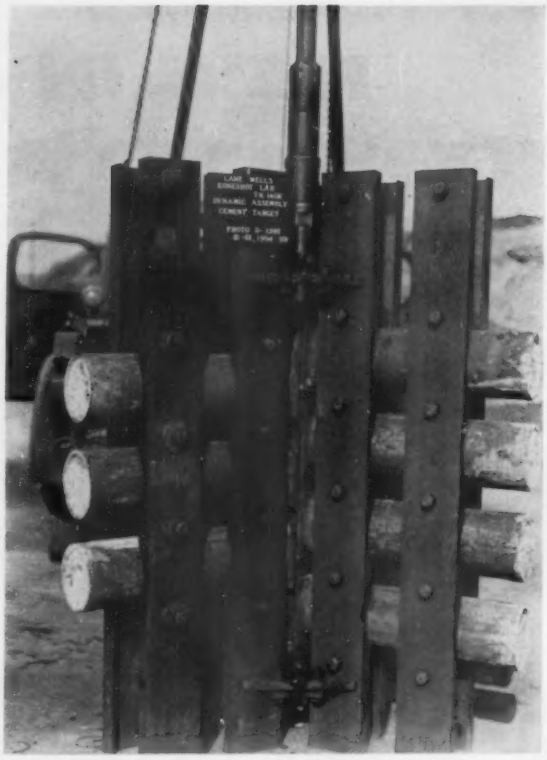

FIG. 9. Jig-mounted core targets are positioned around a gun to be tested and the entire assembly is lowered into a pit and covered with water for dynamic tests of perforators.

High pressure lines, passing through the cylinder head, provide the means to simulate the fluid flow phases during and after perforating. Temperature measuring devices record and help maintain temperatures of the bath around the cylinder, in the cylinder, and at the face of the target.

The test consists of bringing the well bore fluid, the gun and the target up to test temperature, usually 180 to 190 F. Pressure is applied to the cylinder and to the formation end of the sandstone target to represent the type of completion. A head in favor of the well bore is applied to simulate conventional completions. A head in favor of the formation is applied to simulate through-tubing or permanent completions. When the conditions are obtained, the gun is fired.

After simulating the change in relative pressures according to the type of completion, a differential pressure across the perforated case is established at a standard figure of 200 psi. This may not represent conditions in many wells, but all procedures are standardized to

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There is no compromise on quality in the production of SPANG tubular products. To make sure that every length of SPANG pipe is as close to perfection as man can make it, every fifth man is an inspector. These perfectionists have at their disposal advanced inspection equipment, such as Magnaglow "black light," 15,000 psi hydrostatic testing and ultrasonic inspection units. This special emphasis on SPANG quality pays off in tubular product performance when the chips are down. Next time you buy pipe, be sure to talk it over with National Supply people who *specialize* in high quality oil field tubular goods. You'll be glad you did.

See next page for information on Spang Hardfacing

Both Spangweld and Spang Double Seal Shrink Thread drill pipe are available in a full range of sizes, including diameters for slim hole operations.

NATIONAL SUPPLY IS THE ONLY COMPANY THAT MANUFACTURES BOTH DRILL PIPE AND TOOL JOINTS

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Spangweld drill pipe and tool joints provide fast, dependable operation. The tool joints are welded to the pipe by an automatically controlled operation that insures accurate alignment. The Spangweld process elimi-

nates two threaded connections, reducing initial cost of the drill string to the user. Each weld zone is checked by Reflectoscope to determine quality of the weld. This Spangweld tool joint connection also allows a small O.D. and maximum bore, a definite advantage for slim hole drilling.

Double Seal Shrink Thread tool joints are another field-proven drill pipe product. This joint is designed with two distinct seal areas, one internal and one external. The threads have no sealing function to perform. The two sealing surfaces and the shrink thread design result in a joint that is leakproof and minimizes possibility of washout. The tool joints can be removed and replaced easily in the field.

Both of these drill pipe products are available with SPANG Hardfacing, a superior protection for tool joints in abrasive formations. A new development in SPANG Hardfacing is described on the following page.

As well depths go lower and drilling costs rise, you'll find the many advantages of SPANG drilling strings give you a good start toward lower operating costs. SPANG drill pipe is readily available in every type and diameter now in use. Get complete information from your National representative, or write to National Supply Division, Armco Steel Corporation, Two Gateway Center, Pittsburgh 22, Pennsylvania.

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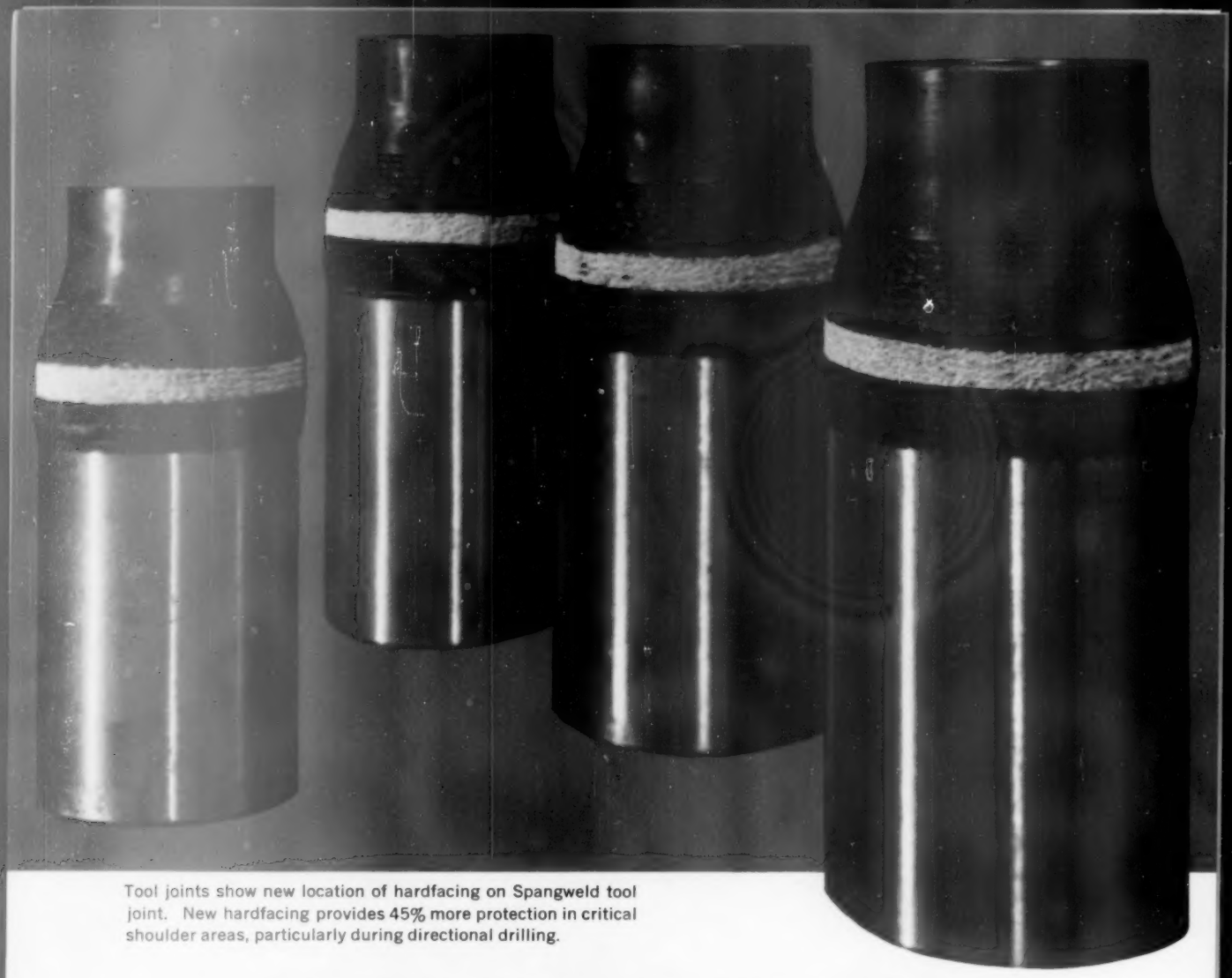

Tool joints show new location of hardfacing on Spangweld tool joint. New hardfacing provides 45% more protection in critical shoulder areas, particularly during directional drilling.

RELOCATION OF HARDFACING INCREASES PROTECTION FOR SPANGWELD TOOL JOINTS

SPANG has now increased hardfacing protection of tool joints with 18° elevator shoulders by relocating the three-inch band of hardfacing. It now extends ⅜-inch farther along the shoulder of the joint.

The new location provides greater protection against undercutting in the critical shoulder area. It provides approximately 45 per cent more hardfacing in this critical area, even though pads have been eliminated.

Field studies have shown that this new location for hardfacing eliminates the need for pads, however they can still be supplied at the customer's request.

SPANG engineers and production experts have pioneered many of the important advances in hardfacing of tool joints. The SPANG process consists of continuously overlapping multiple bands of tungsten carbide on the joint to form a solid particle-to-metal band. The method of application employed by SPANG is the tungsten inert gas welding process.

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By-Pass Ports Are Located Above Hold-Down to Minimize Equalization Problem

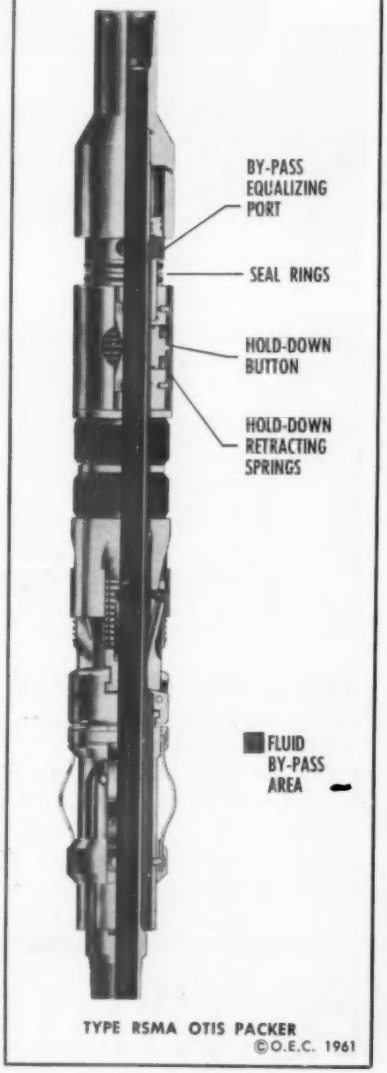
DALLAS — How better can you anchor a packer in a well than to utilize the pressure that is trying to force it up the hole to help lock it in position? That's the design principle employed by the hydraulic hold-down of the new Type RSMA Otis Packer.

Type RSMA Otis Packers are a series of retrievable, tubing set packers rated to 7,500 or 10,000 p.s.i. at 300° F. They combine several new and unique features with many of the time-tested advantages of other Otis Packers to provide the industry a more reliable "hookwall" packer. The tool has a standard J-Latch arrangement with provisions to automatically relock the packer in the running position while in the hole for resetting.

Design Principles of Hydraulic Hold-Down

The Type RSMA Otis Packer uses a new and somewhat unique hold-down mechanism. The principles employed in the design of this mechanism are as follows: In the running position the hold-down buttons located just above the packer's resilient elements are held retracted by individual retracting springs and isolated from the fluid pressure in the tubing. Once the packer is set, the hold-down buttons are exposed to pressure below the packer through an equalizing bypass area between the packer's inner mandrel and outer body which is sealed at the top. This permits the pressure from below the packer, which is trying to force it up the hole, to expand the hold-down buttons. The greater the pressure from below the packer, the greater the force exerted on the hold-down buttons. The combined casing contact area of the hydraulic hold-down buttons on the 5½" model totals 16 square inches, an area considerably greater than available with a tubing-type hold-down.

Picking up on the tubing to release the packer when retrieving opens the by-pass area to permit equalization



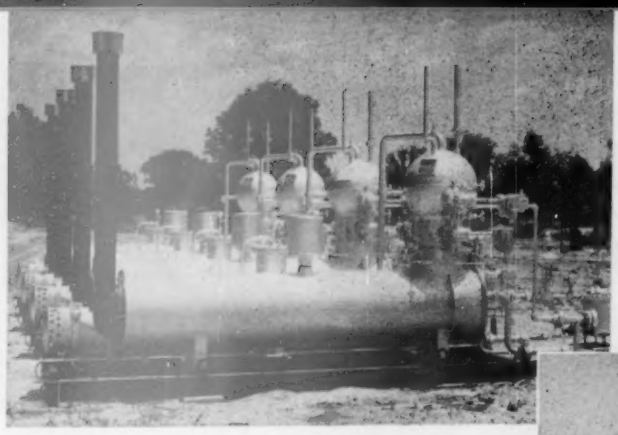
TYPE RSMA OTIS PACKER
©O.E.C. 1961

across the packer. Once pressure has been equalized, the leaf-type retracting springs on each of the hold-down buttons serve to retract the hold-down.

Advantages of RSMA Design Principles

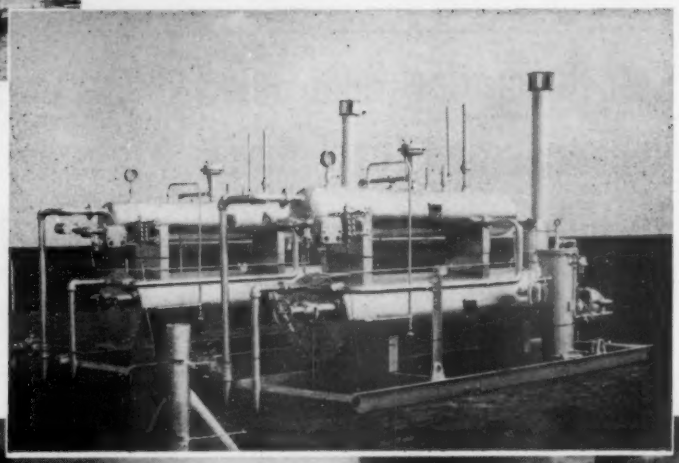
The Type RSMA Otis Packer is designed to be run in the well on tubing and set by one-third turn of the tubing at the packer, setting down tubing weight to expand the resilient elements. It has a full-opening bore to pass standard size wire line tools, perforating guns, pressure bombs, etc. The tool is available with a choice of resilient packer elements. The 5½-inch model is designed to set in a wider range of casing weights (13 to 20 lbs.), without modification, than any other retrievable tubing set packer of this type and yet the resilient packer elements have a smaller outside diameter than the O.D. of the smallest metal part of the packer's body. This feature is designed to protect the resilient elements from junk, etc. when running, retrieving and resetting the packer.

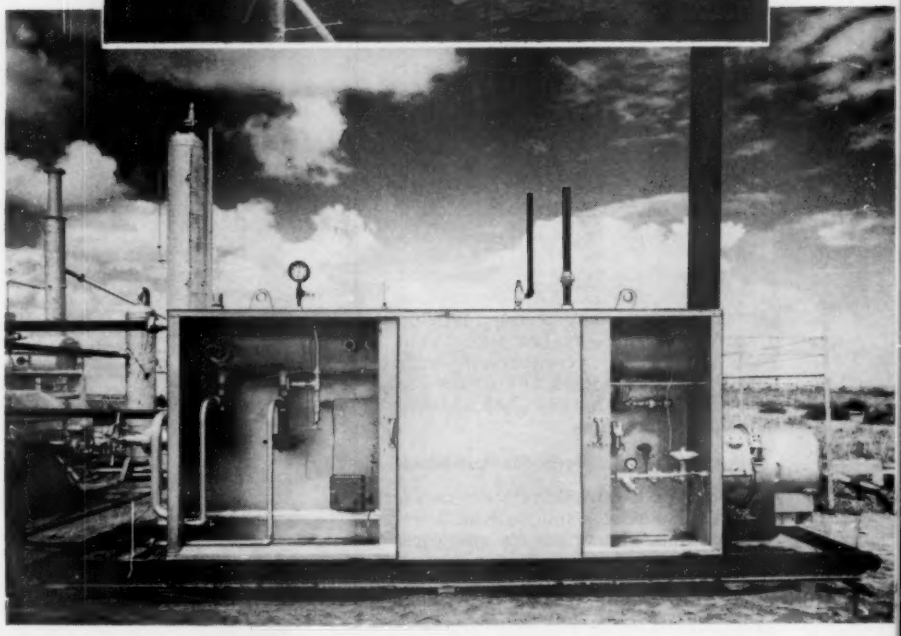
The Type RSMA Otis Packer is another example of the knowledge and ingenuity of the packer design section of the Otis Engineering Department. Although advanced in concept, this new tool utilizes operating principles tested by years of performance in the field. When you combine the advantages of new Otis production tools like the Type RSMA with the experience and knowledge of your local Otis Packer Specialist, you will find you are getting the finest in service and performance. For more information on the Type RSMA Otis Packer or for information on other Otis field-proven packers, call the Otis office nearest you or write Otis, Dept. E-5, P. O. Box 35206, Dallas 35, Texas. You'll find experienced service specialists ready to help you . . anxious to serve you . . with the widest variety of field-tested production tools available today.



Free-O-Freez

PUTS ON AN OVERCOAT





Efficient, trouble-free production in all types of weather. This is what every operator wants from his wellhead production equipment.

A few years ago BS&B went a long way toward achieving this by introducing FREE-O-FREEZ . . . a line of compact, automatic skid-mounted production units that featured immersion of the water-oil section of the separator in a hot water bath and location of controls as close as possible to the heat source.

These units have proved themselves under severe weather conditions in the Panhandle, Permian Basin, and Four Corners area.

But there are still instances where production units need to be fully protected because of extreme cold, high moisture, or blowing dust that tend to foul up controls and valving.

So now you can get FREE-O-FREEZ with an "overcoat" . . . with all the time-tested features of other FREE-O-FREEZ equipment, of course.

Ask your BS&B Salesman about FREE-O-FREEZ, or write to Black, Sivalls & Bryson, Dept. 1GY11 Box 1714, Oklahoma City, Oklahoma.

DESIGN FEATURES

- *Controls, piping, and valves completely housed, protected against cold, dust and moisture.*
- *Skid-mounted, completely piped for immediate field hook-up.*
- *Removable firebox located at opposite end from tube bundle.*
- *Tube bundle easily removed for service.*
- *Heater capacities: 250,000 BTU/hr. and higher.*
- *Available with 2 or 3 phase separators.*

BS&B

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Drawworks with Guts to Go ...for Years

No lightweights, those Brewster drawworks. There's a legion of men in the oil world who will testify to that.

TAKE BREWSTER'S N-55 ROTARY RIG DRAWWORKS

This medium depth drawworks has the ruggedness and brawn typical of all Brewster drawworks. Depth rated to 8,000 feet with 4½" drill pipe, it uses a maximum of 600 horsepower. Clutches are mounted outboard on the main drum shaft for ease of servicing. The entire drum shaft assembly is a complete unit and may be removed in the field for maintenance or service. The drum core is formed from thick walled steel, heavily ribbed to prevent crushing.

TRANSMISSION

The compact chain transmission features Brewster's field proved graduated speed design with four forward speeds, each a 38% increase. When combined with the high and low drum drives, eight forward and two reverse speeds are available for hoisting. Four forward and two reverse speeds are available to the rotary.

COMPOUND

Box type oil bath roller chain compounds are provided for either two or three engine hook-up. By means of individual clutches, motors may be used singly or in combination for individual operation of the pump and drawworks. Fawick air clutches connect each engine to compound shafts, thus providing air-cushioned power, and eliminating many parts.

BRAKES

Brakes are full 325° wrap, having 1" x 8" linings on 40" diameter drums, with a total braking surface of 1,728 square inches. They are of the compound equalizing type and are self-energizing to provide holding power with minimum manual effort.

Get complete information on Brewster equipment now. See your Brewster dealer or write or call Brewster.

SPECIFICATIONS BREWSTER N-55

Recommended Horsepower	600
Drum Brake Diameter x Width	40" x 8"
Drum Core Diameter x Length	16" x 40"
Size of Brake Lining	1" x 8"
Net Braking Surface (Lining) Square Inches	1,728
High Speed Drum Clutch	Fawick Friction
Low Speed Drum Clutch	Fawick with Positive Auxiliary
Transmission:	
Forward Speeds	4
Reverse Speeds	1
Size Main Skid Members	12 x 12 H
Approx. Overall Height	72"
Approx. Width of Skids	7' 1"
Length	26' 8"—2 Eng.
Length	30' 10"—3 Eng.
Approx. Weight of Drawworks, less engines	36,000 lbs.

Brewster MATCHED Drilling Equipment for the N-55 Drawworks includes the Model TB-1[illegible] Block, the RSH-18 Rotary and the 4-SX Oil Bath Swivel.

BREWSTER N-55

ROTARY RIG DRAWWORKS

Fast drawworks for medium depth drilling available with Torque Converter, Fluid Couplings or Direct Mechanical Drive

THE BREWSTER COMPANY, INC.

P. O. BOX 1095, SHREVEPORT, LOUISIANA
TELEPHONE 424-3254

PRODUCTS OF CREATIVE ENGINEERING

eliminate as many variables as possible because we wish to observe the relative productivity of the perforation. Productivity is a function of rate or fluid flow through the perforated target. Rate of flow with viscosity of the fluid at test temperatures is plugged into standard permeability formulas to obtain a figure for observed permeability of the perforated core.

In preparation of the sandstone core, permeability was measured by standard laboratory procedures involving measurement of porosity, flooding with a 3% salt water solution and flushing to a connate water condition with kerosine. Kerosine is used throughout the test procedure to represent the formation fluid. The ratio of the observed permeability of the perforated core to the measured permeability of the unperforated core is the well flow index. A WFI of 1.0 has been considered good, in that the perforated core had the same permeability, or productivity, that it had prior to perforating. Well flow indices of 1.2 to 1.5 are not uncommon. A well flow index of less than 0.5 has been observed in some commercial perforators.

The flow lab has contributed much to the study of the effect of fluids and to our ability to compare the effectiveness of perforators. The latter use in development work has been the most fruitful use. Perforators, shaped charge ones in particular, have been improved immensely through observation of productivity. Plugging, due to deposition of material from the charge itself, has been reduced to the point of elimination. The character of the hole has been altered to obtain the optimum balance of depth and diameter for maximum productivity.

Field testing and field demonstrations have always been a part of perforating. The competitive spirit has been made evident in demonstrations to show performance. This, and the requests to demonstrate ability to penetrate specimens of unusual downhole conditions, have brought most of the laboratory testing techniques into the field. Originally, we saw tests in concentric strings of casing with neat cement in the annulus. This setup served as a demonstration, but comparison of performance was unsatisfactory. The neat cement target came next. It was the forerunner of the Berea target.

Fig. 9 shows how the Berea targets are jig-mounted to make a dynamic test of a field perforator. Jacketed cores are positioned on the axis of the charges or bullet gun barrels and at the shot density of the gun. The entire assembly is lowered into a pit and covered with water to a head of at least 6 in. over the top port of the gun. One advantage not found in other tests is the measurement of performance under dynamic shooting conditions. If there is any effect from adjacent charges, the effect will show up in the perforated targets.

Another evaluation from laboratory testing is the dynamic steel bar test. Here a similar jig is used to position mild steel bars opposite the ports of a field gun. The test gives information similar to that obtained from the sandstone target test, but in terms of steel bar penetration.

In the past the user of perforators has been assailed from every side with claims, data and demonstrations of performance. Often the values for the performance were the only specific figures. Description of the target did not always include specific data, and if it did, there was some doubt as to whether the target could be duplicated. Through efforts of a few men and companies in the industry, there has evolved a satisfactory method of laboratory evaluation of perforators.

Admittedly, reservoir conditions from well to offset well may vary to the same degree that laboratory tests vary. Also, there are variations in completion procedures which follow perforating. Perhaps a statistical evaluation within a given reservoir or location is the only practical approach.

Nevertheless, the oil producer is the only one who can provide the final evaluation type against type, brand against brand, claim against claim. The real evaluation comes in the evaluation of final results: barrels of oil, or cubic feet of gas.

This field observation of results will apply not only to natural production through perforations, but also to effectiveness of the perforations in well stimulation and injectivity in flood and recycling operations.

About the Author

F. O. Bohn is chief ballistics and mechanical engineer of Westheimer Manufacturing Co., the engineering and development division of Lane-Wells Co., a Dresser Industry. Graduated from the University of Oklahoma in 1935 with a BS degree in electrical engineering, he joined Lane-Wells Co. in 1935, serving as field and division engineer in the Gulf Coast Division until 1941. After five years in the U. S. Army, he rejoined Lane-Wells and spent 8 years in field liaison work with field engineers in North America before being made coordinator of perforating services. He was appointed to his present position in March 1960.

■

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Bethlehem pump shops are staffed with experts—men with practical experience in the repair and operation of subsurface pumps. Every one of our shops has complete repair facilities and a full stock of replacement parts. Bethlehem pump experts can quickly diagnose the ills of any troublesome or worn-out pump. And they can put it back into top shape in a hurry.

Select a Beeline pump from our complete line

Bethlehem's the place to shop for new pumps, too. Our popular *Beeline* series of subsurface precision pumps includes one which will meet your needs exactly, whatever the condition of your well. Each *Beeline* pump is engineered to the same high standards which characterize all Bethlehem equipment.

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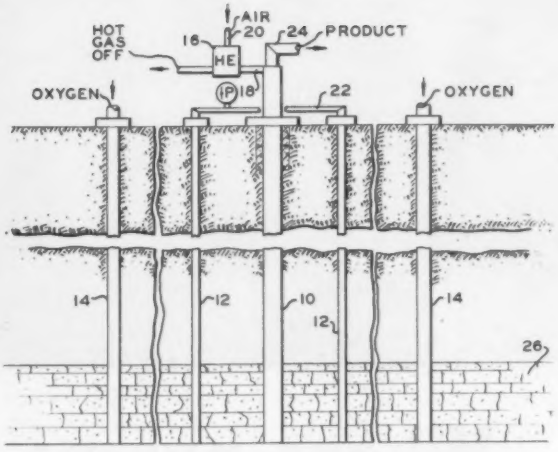
Supply Division
General Offices and Export Dept.: 21 East Second St., Tulsa, Okla.

BETHLEHEM STEEL SUPPLY DIVISION

What's New in Patents

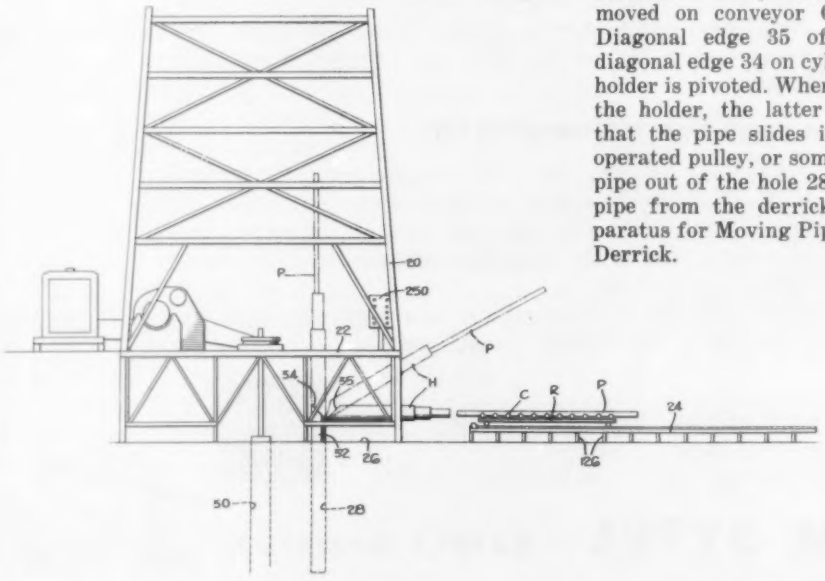
In Situ Combustion Works in Reverse

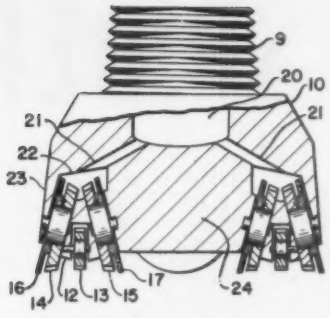
A process for starting underground backward-type combustion is described in this patent. Heated air of about 300 F is forced into the formation which is penetrated by a combined ignition and production well and separate injection wells spaced around the combined well. Heated air is injected until the formation temperature reaches about 250 F, or at least above the boiling point of connate water. A combustion gas heater then ignites the carbonaceous material in the formation. An oxygen-containing gas is then forced into the strata from the injection well to the ignition well to advance the combustion zone counter-currently to the flow of the gas. Patent No. 2,999,539, In Situ Combustion Process.



Automatic Device Racks Drill Pipe

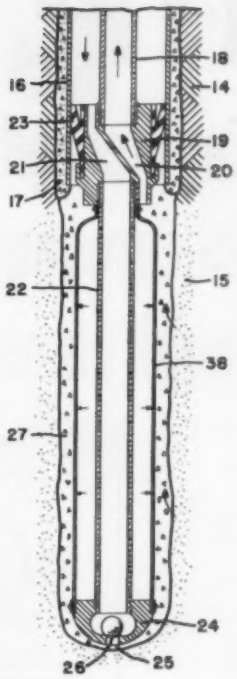
A novel and practically automatic means for moving pipe into and out of an oil well derrick is described in this patent. Pipe P, stored on rack R, is moved on conveyor C into cylindrical holder H. Diagonal edge 35 of the holder corresponds to diagonal edge 34 on cylindrical liner 32, to which the holder is pivoted. When part of pipe P is pushed into the holder, the latter is elevated hydraulically, so that the pipe slides into mouse hole 28. A cable-operated pulley, or some hydraulic device, pushes the pipe out of the hole 28 into holder H to remove the pipe from the derrick. Patent No. 2,999,605, Apparatus for Moving Pipe Into and Out Of an Oil Well Derrick.

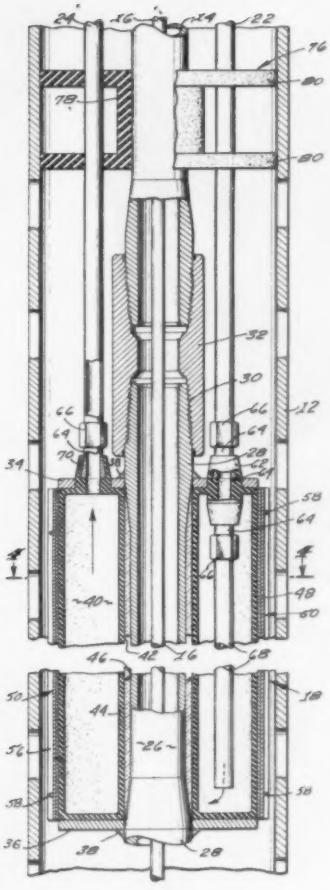




Bit Stresses Rock Before Cutting

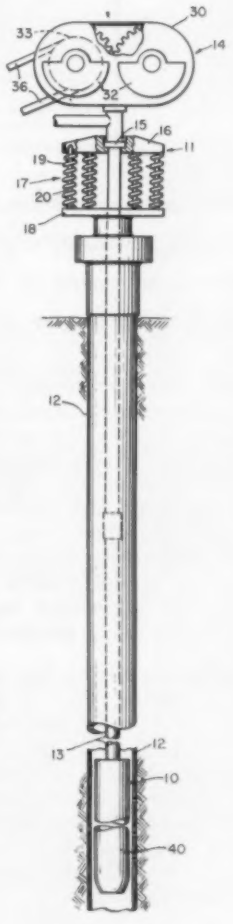
Assemblies of cutters arranged about the bottom of this rotary drill bit induce tensile stresses in the formation being drilled, thereby reducing strength of the rock. Each assembly has a pair of sharp edged disc-like cutters 16, 17 with or without a toothed or corrugated rim. Between these two inclined cutters is a roller type cutter 13 slightly recessed so that contact with the formation is delayed until the other two cutters have been spread by the drilling weight and load. Patent No. 2,998,857, Drill Bit.





Mechanical Pressure Drops Sloughing Formations

This invention is a process to stabilize productive formations by creating a mechanical pressure with a fluid to counteract the pressures which tend to slough the formation. The pressure should be substantially equal to, but not exceed, the overburden pressure to prevent fracturing the formation. An expandable perforated sleeve, liner or gravel pack is placed adjacent to the formation to be treated. The pressure is continuously applied against the formation during production of the well fluids. The patent describes the various methods, along with a typical example, for creating correct pressure conditions. Patent No. 2,998,065, Method and Apparatus for Stabilizing Productive Formations.



Hot Water Powers Downhole Heater

Hot water circulates inside this oil well heater which is located at or near the bottom of the hole. The heater consists of a flexible bag 40 surrounded by metallic ribs 56. The device is lowered into the hole with the bag deflated which makes it easy to move it through the casing. When in position, water is circulated in the heater. Pressure of the water expands the flexible bag 40, pushing the ribs 56 against the casing 12 to improve conductivity of heat through the casing and on to the surrounding well fluids. Patent No. 2,998,069, Oil Well Heater.

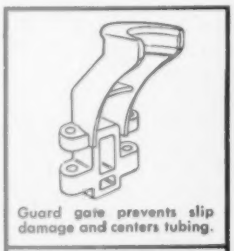
These patents were selected by Paul H. Johnson and James R. Head, patent attorneys in Tulsa, Oklahoma. If you want a copy of these patents for further study, write the Commissioner of Patents, United States Patent Office, Washington, D.C. Price is 25 cents for each copy.

Sonic Energy Heats, Pumps Viscous Oil

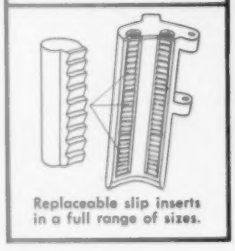
This invention uses sonic waves to heat oil in the bottom of a well. A sonic generator 14 at surface of well induces sonic waves in tubing 13 which transmits them to a sonic well heater 10 at the bottom of the hole. The heater consists of a tubular casing 40 having a number of internal baffles with small openings for the oil to flow through. The rapid back-and-forth movement of oil through the small openings causes the oil to heat. Patent No. 2,999,540, Sonic Heater for Wells.

TYPE F1 TUBING SPIDER

Engineered by Guiberson for present day requirements

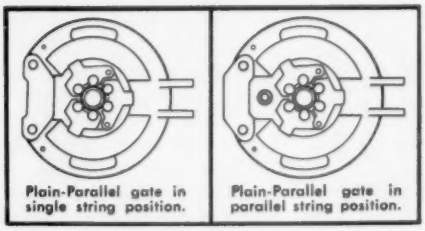


Guard gate prevents slip damage and centers tubing.



Replaceable slip inserts in a full range of sizes.

Fast, safe, one-man operation.
Strong, trouble-free design.
Choice of gates at no extra cost.
Multiple pipe-size slip bodies.



Plain-Parallel gate in single string position.

Plain-Parallel gate in parallel string position.

You can handle any length of tubing string in utmost confidence with the heavy duty F1 tubing spider. Design features include a wide safety margin of built-in strength . . . fast, efficient, one-man, hand or foot operation . . . and three point slip contact for automatic alignment and even load distribution. Optional at no extra cost is a guard gate which centers tubing and protects the slips or a reversible plain-parallel gate which handles a single string in one position or parallel strings in the other.

Multi-size slip bodies offer added economy and convenience. The 1″ slip body accommodates ¾″ or 1″ slip inserts. The 2″ body handles 1¼″, 1½″, 1¾″ or 2″ inserts. The 2½″ body handles 2″ or 2½″ inserts and a 3″ body with 3″ inserts is also available. Slip inserts are easily changed and economically replaced when necessary. Dependability, durability and versatility class the F1 as today's outstanding buy in tubing spiders.

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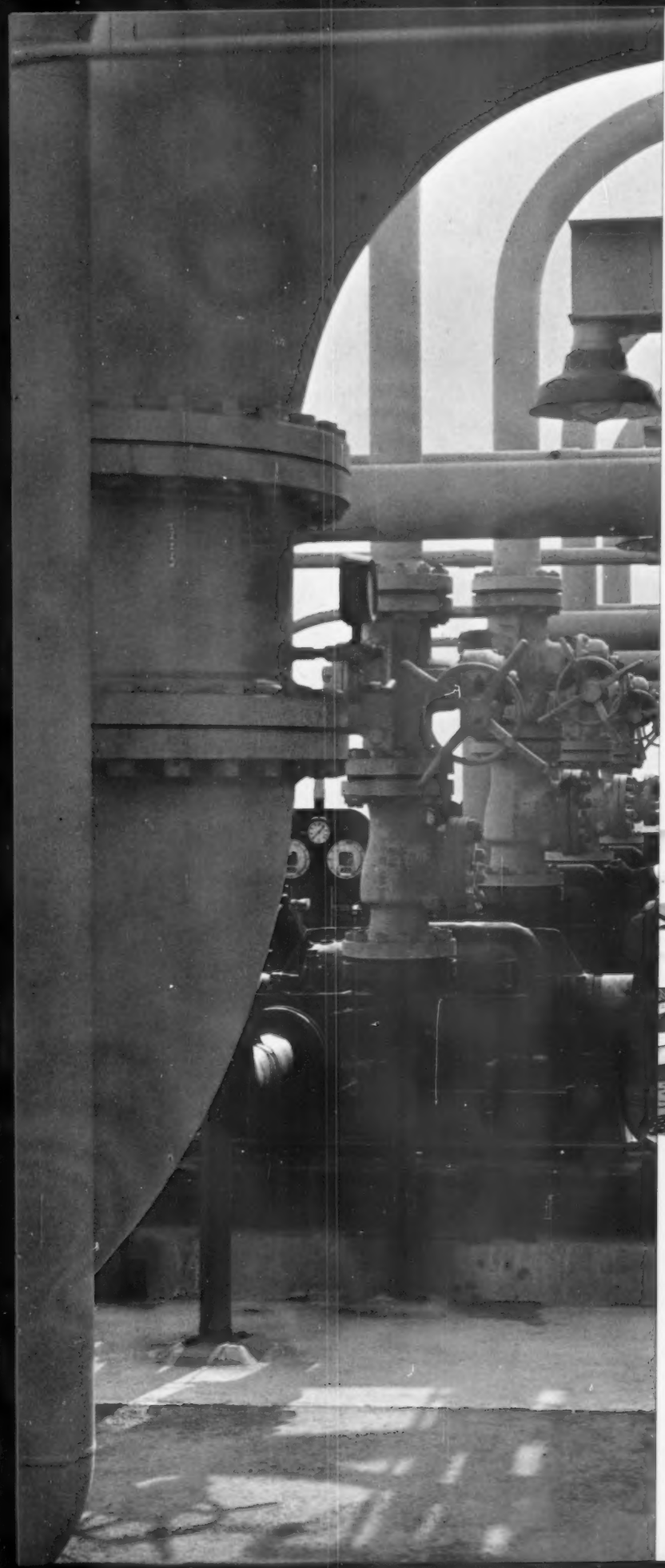

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The only complete line of pumps for

water flood

- *water supply*
- *injection pumps*
- *oil well pumps*
- *booster and transfer pumps*

BJ Pumps for every waterflood and secondary recovery project!

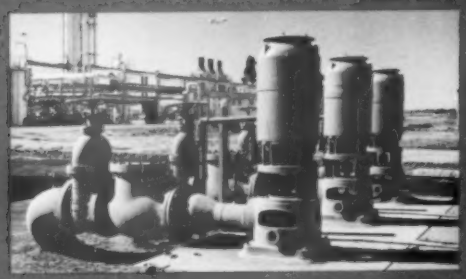
Byron Jackson's complete line of centrifugal pumps for waterflood and repressurization operations include sizes and capacities for any requirement . . . deepwell and submersible pumps for source water supply; booster and transfer pumps for treatment and process handling of raw water; injection pumps for input under any pressure needed; and submersible oil well pumps for secondary recovery of crude oil.

From one of the earliest pioneering waterflood installations—at Bradford, Pennsylvania in 1934—to the World's largest subsidence and well repressurization project in the Los Angeles Harbor—Byron Jackson has been supplying pumps for this specialized service.

Whatever your requirements, there's a standard BJ design for the job, with special metallurgy and construction available as needed. All BJ Pumps are backed by the long experience and reputation of a quality manufacturer!

INJECTION PUMPS—*Four of eight BJ DVMX Pumps in the Los Angeles Harbor mainland injection station. A similar island plant has six more DVMX Pumps with a total capacity of 444,000 barrels per day—the World's largest waterflood operation!*

OIL WELL PUMPS—*Installing a BJ Centrilift Submersible Pump. This sealed motor-pump unit goes down standard casing for efficient, high volume recovery of oil at any depth, or for water supply in small diameter wells (5½" O.D. and larger).*

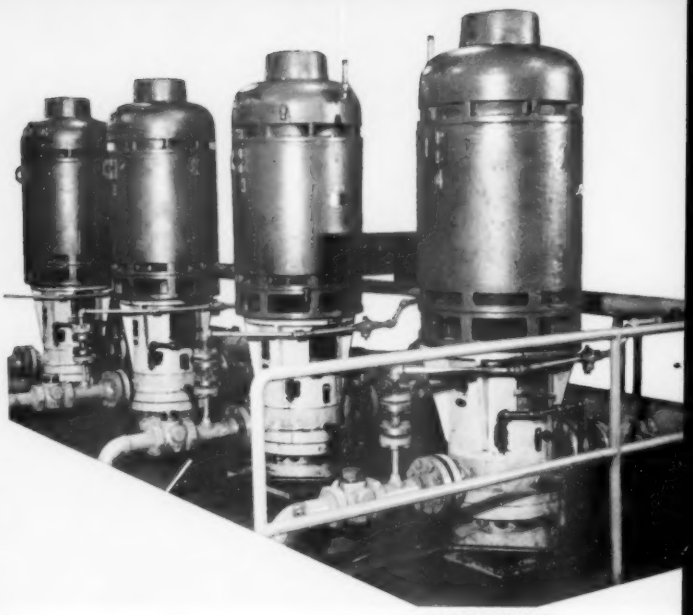


WATER SUPPLY PUMPS—*The same dependable BJ design, proved in thousands of industrial, municipal and agricultural installations, is now providing the large volumes of water necessary for major waterflood projects.*

BJ

PUMPS FOR WATERFLOOD

The only complete line of pumps for waterflood service ...proved in water supply, transfer, booster pumping, water injection and oil well pumping!



PUMP SELECTION CHART

SERVICE	RECOMMENDED PUMPS AVAILABLE	TYPE	PERFORMANCE RANGES
WATER SUPPLY	Deepwell Turbine	Vertical	Capacities to 110,000 bbl/day
	Submersible (For wells 8" I.D. and larger)	Vertical	Capacities to 110,000 bbl/day
	Subette (For wells 6" I.D. and larger)	Vertical	Capacities to 10,000 bbl/day
	Centrilift (For wells 5½" O.D. and larger)	Vertical	Capacities to 17,000 bbl/day
INJECTION PUMPS	DVMX	Horizontal	Capacities to 100,000 bbl/day Pressures to 3,000 psi
	DCI (Double Case)	Horizontal	Capacities to 200,000 bbl/day Pressures to 5,000 psi
	Hydropress	Vertical	Capacities to 20,000 bbl/day Pressures to 4,000 psi
OIL WELL PUMPS	Centrilift (For wells 5½" O.D. and larger)	Vertical	Capacities to 17,000 bbl/day
BOOSTER PUMPS	VLT	Vertical	Capacities to 70,000 bbl/day Pressures to 250 psi
	VMT	Vertical	Capacities to 1,500,000 bbl/day Pressures to 1,000 psi
TRANSFER	Bilton	Horizontal	Capacities to 40,000 bbl/day Pressures to 225 psi
	SMJ Process	Horizontal	Capacities to 50,000 bbl/day Pressures to 650 psi
	SM Process	Horizontal	Capacities to 135,000 bbl/day Pressures to 850 psi

Complete information on BJ Pumps for waterflood service is available — phone or write today for Bulletin 1-1710.

These two horizontal DVMX pumps in a waterflood project provide a total of 46,700 barrels per day at 1440 psi. Four high pressure, vertical BJ Hydropress Pumps, shown at upper right, are combined for high capacity waterflood service.

Byron Jackson Pumps, Inc.

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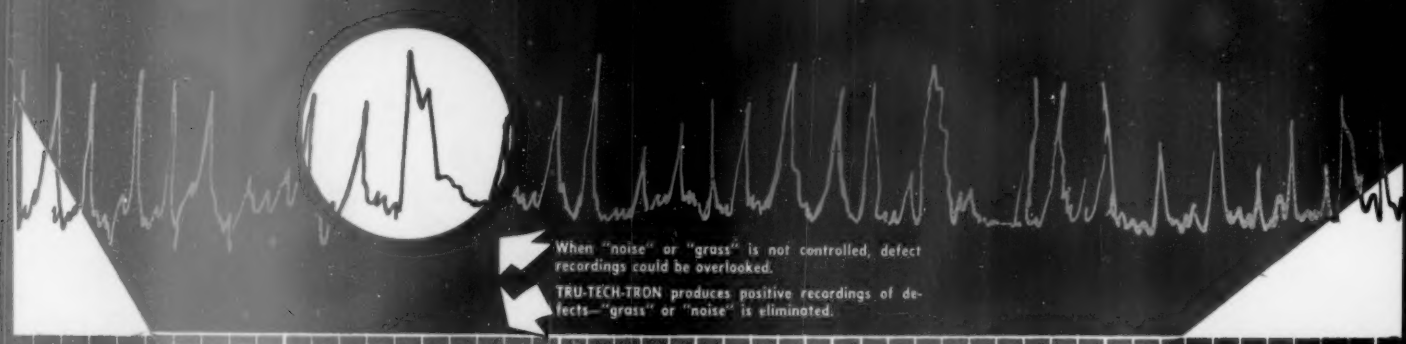
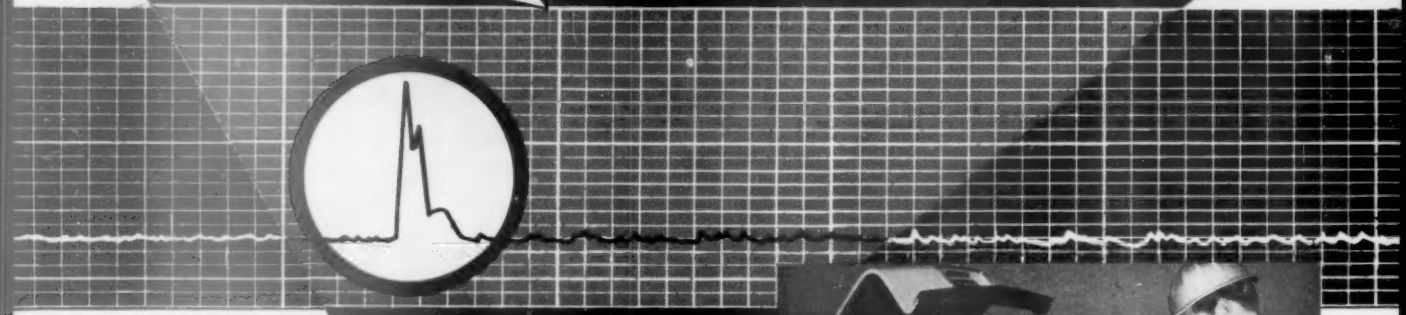

When "noise" or "grass" is not controlled, defect recordings could be overlooked.
TRU-TECH-TRON produces positive recordings of defects—"grass" or "noise" is eliminated.



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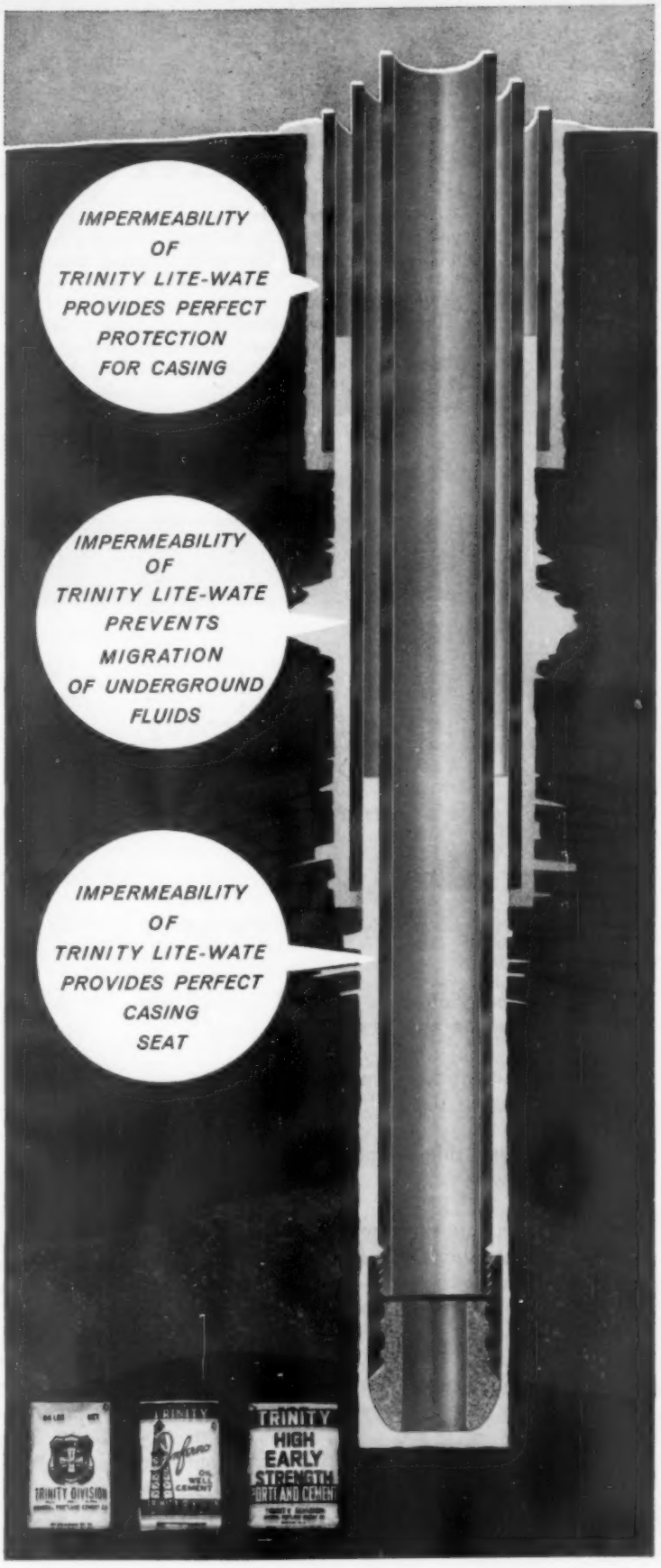
Trinity Lite-Wate fulfills all important functions when placed in an oil or gas well.

PERMEABILITY TEST DATA

All slurries were prepared according to procedures of API RP IOB and cured at 140°F and atmospheric pressure for 72 hours.

Percent Mixing Water	Slurry Wt. Pounds Per Gallon	Permeability Millidarcys*
65	13.66	0.001
75	13.18	0.001
85	12.77	0.001
95	12.44	0.001
105	12.14	0.002
115	11.89	0.003

*A darcy is that measurement of permeability that will permit a liquid having a viscosity of one centipoise to flow at the rate of one milliliter per second through a specimen one centimeter in length and having a cross section of one square centimeter under a pressure difference of one atmosphere. A millidarcy is 0.001 darcy. The permeability of Trinity Lite-Wate cement is expressed in millidarcys.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IMPERMEABILITY OF TRINITY LITE-WATE PREVENTS MIGRATION OF UNDERGROUND FLUIDS
IMPERMEABILITY OF TRINITY LITE-WATE PROVIDES PERFECT CASING SEAT
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What's Ahead in Contract Drilling

Last month we presented the views of seven key industry leaders on the nature of contract drilling in the future. It was our intention to include under the same report interviews with George B. Kitchel, vice president, Kerr-McGee Oil Industries, Inc., of Houston, Tex., and Walter Kalteyer, vice president, Hunt Drilling Co., Corpus Christi, Tex.

Hurricane Carla struck a hard blow to coastal Texas and Louisiana . . . the precise areas in which both men manage drilling operations. Interviews had not been fully completed when Carla struck, and the full time and energies of our interviewees were badly needed in their own jobs. All forms of communications were disrupted at presstime last month, and comments of these two drilling executives were delayed. Because what they have to say is of such vital importance to those concerned with offshore drilling and with Texas Gulf Coast inland operations, their remarks are presented now.

— by J. E. KASTROP

"Offshore activity steady . . . may increase slightly"

George B. Kitchel, vice president, Kerr-McGee Oil Industries, Inc., Houston, Texas.

Q. How many offshore rigs are running now off the Louisiana and Texas Gulf Coast?

A. I would estimate between 58 and 60 rigs are operating in the Gulf of Mexico.

Q. How does this compare with any previous high and low?

A. At one time there were probably as many as 66 or 67 offshore rigs in operation, or about six to nine more than the number now working. About three years ago only 39 or 40 rigs were operating.

Q. How does the offshore activity look to you now for the remainder of this year?

A. I would say offshore activity will continue at about the current pace of approximately 55 to 60 rigs, which is about all available deep water rigs. Rigs having a water-depth capacity of less than 40 ft. may not experience this same degree of activity.

Q. Is there a demand for deep water rigs now?

A. Any rig that can operate in the hurricane season in water deeper than 40 ft. is in demand and working.

Q. What about offshore activity next year and beyond? Is it still going to be steady?

A. We think it will be reasonably steady, with a gradual increase of one, two and maybe three rigs as new rigs become available.

Q. What are some of the factors responsible for this continued high offshore activity?

A. There are still plenty of structures to be tested and practically all of them will require additional development wells.

Q. Are these structures in relatively deep water?

A. We are moving further out into the Gulf. Fields nearer the shore and in shallower water have been developed more than those further out, because it is cheaper to drill and produce them.

Q. A lot of contractors over the U. S. probably are not really aware of what's going

SIX REASONS WHY O·C·T CASING HANGERS OUTPERFORM OTHERS

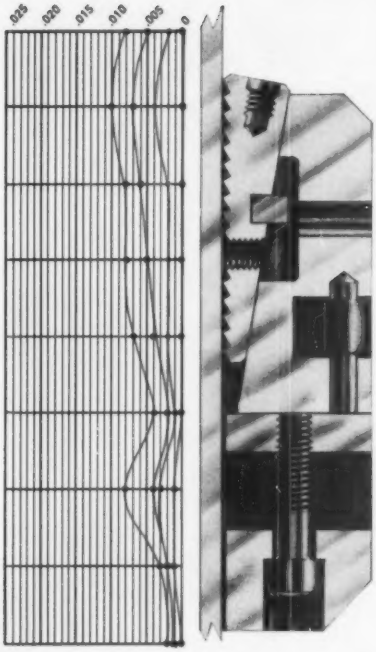

Fig. A.

The curves above show inward diametrical deflection of 5½-inch J-55 casing suspended in a C-22 casing hanger. Deflection is plotted in 0.001-inch units at 9 points. Test loads were 60,000, 120,000, 180,000, and 230,000 pounds.

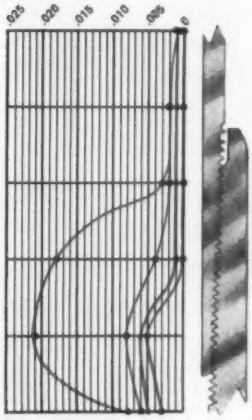

Fig. B.

These curves show inward diametrical deflection of a standard API coupling at various points. During the pull tests, this coupling was placed below the C-22 casing head for which deflections are shown in Fig. A. Deflections plotted in Fig. B were observed at the same time and at the same loads as these in Fig. A.

1. Slips in O-C-T casing hangers cause only minimum casing deformation. For example, a typical O-C-T hanger, the C-22, actually **causes less deformation than a standard API coupling!** Results of pull tests at casing loads up to 230,000 pounds appear in Figures A and B. These results mean that O-C-T casing hangers cause little reduction of casing I.D., giving you full-bore access for tools. These hangers also give you dependable casing suspension, with no danger of slipping caused by excessive pipe deflection.

2. O-C-T's slip-bowl design (See Fig. A) gives you automatic shock-absorbing action that protects casing heads by converting a large part of any sudden load shock into a downward force component. This helps explain the remarkable fact that **no O-C-T casing head has ever split in service!**

3. O-C-T's slip-bowl hanger design does not allow seat wear to change the angle of the slips. Many other hangers with slips that engage the casing head directly no longer remain at the proper angle as seat wear occurs.

4. The 45° angle of O-C-T casing head seats gives superior load-bearing qualities and reduces compression forces on casing. Many other hangers are designed with 7-10° seat angles that produce excessive compression.

This test equipment was used to obtain deflection data presented in Figures A and B. The hydraulically operated device at left can test tubing and casing hangers at loads as large as 1,000,000 pounds.

5. O-C-T casing hangers are always designed to provide all the practical load capacity needed in properly designed casing strings.

6. Weight is evenly distributed on packing in O-C-T hangers automatically. Many other hangers require manually setting screws to distribute weight properly.

For more information on the design advantages you get from O-C-T casing hangers, see your O-C-T representative. His know-how and experience are at your disposal from the time you start planning your completion until your O-C-T wellhead is set in place.

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2. Eliminates Risk of Unscrewing Rods!
3. Permits Raising, Lowering or Re-Setting Pump Without Pulling Tubing!

Here's a combination pump anchor and pack-off that is the ideal solution for wells where a shoe or seating nipple has not been provided for the pump. It's the Oilmaster Insert Pump Anchor—a *vertical setting* pump anchor that requires no rod rotation (either forward or backward) to set, release, pack-off or re-position the anchor in the well.

- **There's no risk of unscrewing the rod string while installing or releasing the Oilmaster Anchor.**
- **The Oilmaster Anchor can readily be set in crooked or directionally-drilled wells.**
- **No clutch arrangement is required on the pump.**
- **The Oilmaster's compression pack-off provides a positive seal, even in worn, pitted or "ring-wormed" tubing.**
- **The Oilmaster Anchor can be set, released and re-set without damaging the packing element. No shear pins are used!**
- **The Oilmaster Anchor provides a positive hold-down, even should the well flow through the pump.**

New! Advanced type of collet design maintains pack-off without wicker devices. It's simple, positive, trouble-free!

Complete Control with Unique VERTICAL Action!

#6. Lifting Position: Pin returns to here as tool is unseated, then remains here as tool is lifted up tubing.
#5. Setting Position: Approximate pin location when tool is "set."
#4. Pre-Setting Position: Pin moves here as rods are lifted for setting. Tool is then lowered to "set" position.
#1. Starting Position: Pin is here as tool is made up on string.
#2. Lowering Position: Pin moves to here as tool enters tubing.
#3. Pick-up Allowance: Pin travels up and down this 24" slot as connections are made.

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COMPARE the above advantages against the pump anchors you are now using. Why jeopardize your wells with anything *less* than the Oilmaster Insert Pump Anchor?

Want More Facts?
Ask for Bulletin 6104 which gives details, cutaway views and operating data. No obligation of course!

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ARMCO Fluid Packed Pump

on as to cost. Can you give any relative information or range on what it costs to drill a well offshore?

A. Many variables, such as the depths of the well and the water through which it is drilled, affect the cost of drilling an offshore well.

Q. What, approximately, is an average footage price for a 10,000 ft. development well in 35 ft. of water?

A. About $9 per ft. Of course, the tangible items would be the casing, tubing and things like that.

Q. What are some of the generalized day rate figures for offshore rigs, say a platform tender or a mobile unit?

A. A platform tender unit would work from $3800 to $4000 per day depending upon a few variable items that sometimes the contractor furnishes and other times the operator furnishes. This would include fuel, large blowout preventers, degassers, cementing and logging units. Some are working now at around $3950 per day.

Q. What would be the day rates for a rig comparable to Kermac's Rig 47?

A. Our Rig 47 would work for about $5300 per day, plus or minus $100 or $200 per day.

Q. What does insurance cost on an offshore mobile rig?

A. The annual cost for insurance is in the neighborhood of 5 to 6% of the investment. Using the six percent rate on a $4,000,000 unit, which is neither the biggest nor the smallest, the annual premium would be $240,000, or about $650 per day.

Q. Is there any best way to drill wildcats offshore?

A. The submersible unit is the most economic rig to drill a wildcat. If you get a dry hole, you just pull the top casing and float the rig away. If some kind of permanent structure is used and a dry hole results, you've lost the structure except for the salvage value. The cost of salvage is high. The services of derrick barges and things like that can cost anywhere from $7,000 to $10,000 per day. Installing the structure and taking it out would cost about $10,000 per day. And it takes several days to do it.

Q. Where will the big mobile units find their best place?

A. The big mobile units, of course, are excellent for wildcatting and in piercement-type dooms where you have to feel around before you can isolate or locate the pay area. After that has been done you can come in with a self-contained platform or tender platform, because you know you are not building the platform as a take-out item. You are assured of production before you build it.

Q. What are some advantages of a large mobile unit like Kermac's Rig 47?

A. Large mobile rigs offer three primary advantages: mobility, economics and the ability to start a well on short notice. At one time the operation of mobile units was limited to relatively shallow waters, but this is no longer true. Our Rigs 46 and 47, for example, can operate in 70 feet of water and our Rig 54, now under construction, will work in 175 feet of water.

Q. Has there been any changes lately in contractor-operator relationships?

A. No. Offshore, the relationship has been good. Back when there were only 40 rigs running and 30 rigs idle, competition was great and the contractors cut their own throats by sharply underbidding each other at lower than cost figures. Now that there is enough work to keep 50 to 60 rigs running, prices have come up to where they are fair between the parties although they are not as high as they were five years ago. Naturally, operators say prices are now a little too high and contractors say they are a little low, but actually there is not a great difference of opinion. Prices are more stabilized.

Q. Have you any ideas or suggestions for improving the contractor-operator relationship for the benefit of both parties?

A. One important need is a more thorough understanding between the contractor and operator as to what the contractor is bidding on and what the operator expects him to do. This would eliminate haggling later when changes are made. This problem doesn't occur when drilling continuously for one operator. But when a contractor goes to work for a new operator, he has a little trouble understanding just what that operator will demand of him.

Q. Is there much turnkey work performed offshore today?

Michael Faraday — discoverer of electromagnetic induction, 1831

From the minds of men . . .

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LEADS IN RESEARCH AND DEVELOPMENT

Georg Simon Ohm — Ohm's law of resistance, 1826

correct timing of frac jobs can improve your profits

More than three years of intensive experience in engineering treatments with the aid of the Frac Guide* has given Dowell engineers an intimate knowledge of how various well characteristics influence results from frac jobs. *Correct timing* of fracture treatments is one of the important lessons learned from this study and experience.

While Dowell engineers are not in the business of reservoir engineering, they *can* help you determine what to expect in the way of payout, folds of increase and treatment costs when you fracture your wells.

The production history shown here of a waterflood demonstrates just one of the many situations where timing of a frac job can be vital to profits.

Notice that the frac program on this flood, which began three years after peak rate of production, resulted in an actual gain of 55,000 barrels of oil. The hypothetical curve shows that the net gain might have been 118,000 barrels of oil if the frac program had been performed 18 months earlier. This would have been 63,000 barrels more than the amount actually recovered.

In addition to increasing recovery, the earlier frac program would have hastened payout and reduced total operating costs. The result would have been greatly increased net profits.

If your decline curves and formation energy records indicate that fracture treatments could help, now is the time to ask Dowell to engineer and compute a treatment program. Don't wait too late. Dowell services and products are available in North and South America, Europe, North Africa, and Iran. Dowell, Tulsa 14, Oklahoma.

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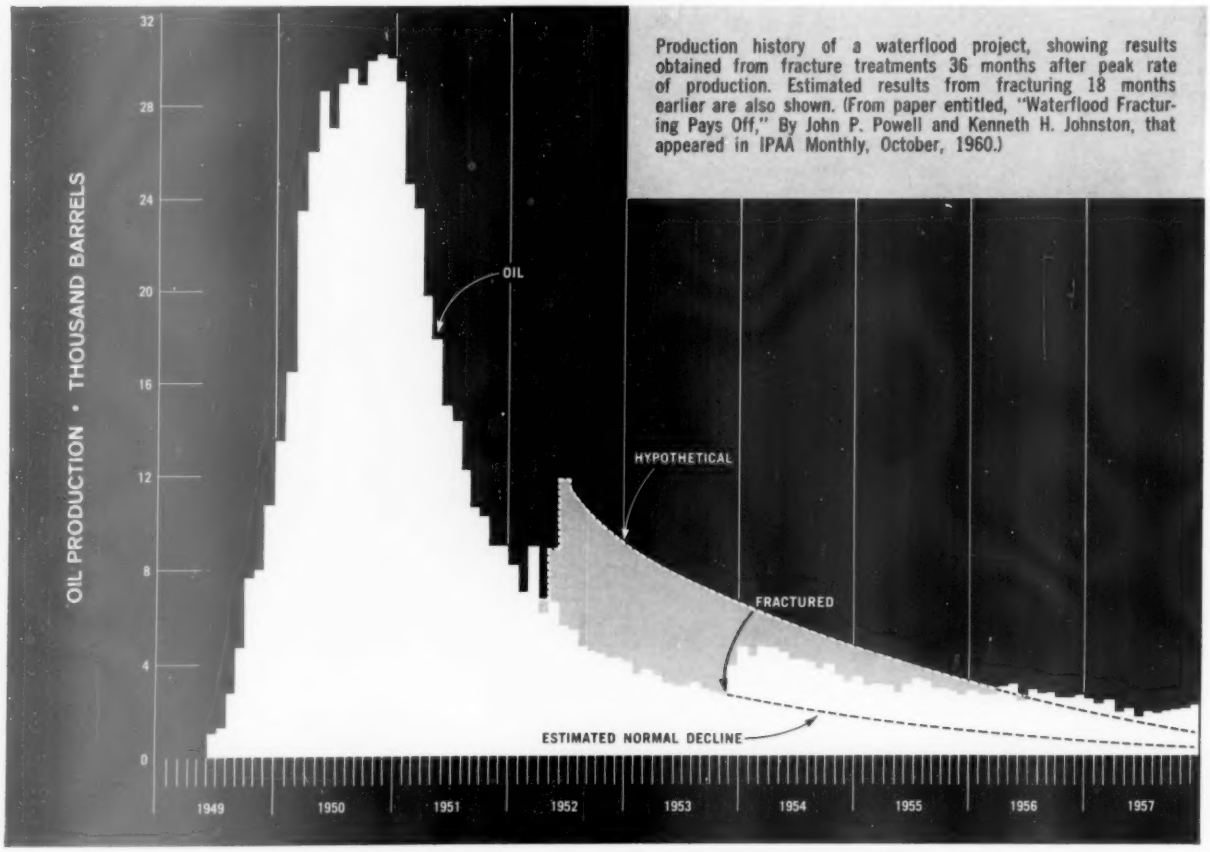

Production history of a waterflood project, showing results obtained from fracture treatments 36 months after peak rate of production. Estimated results from fracturing 18 months earlier are also shown. (From paper entitled, "Waterflood Fracturing Pays Off," By John P. Powell and Kenneth H. Johnston, that appeared in IPAA Monthly, October, 1960.)

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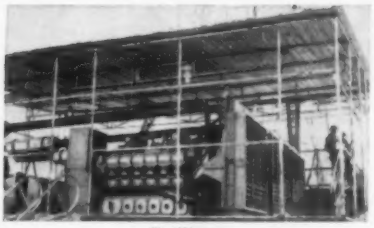
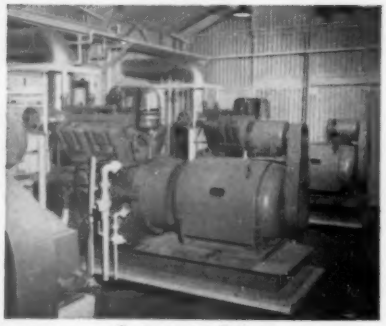
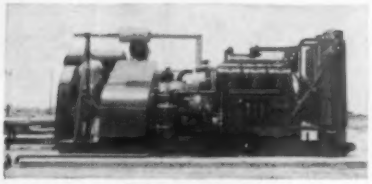


Drilling



Generator Drive

Pipe Line



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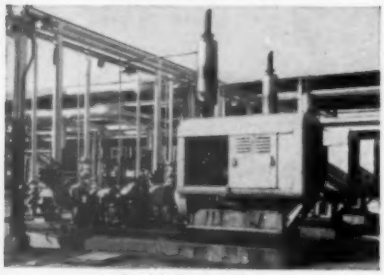
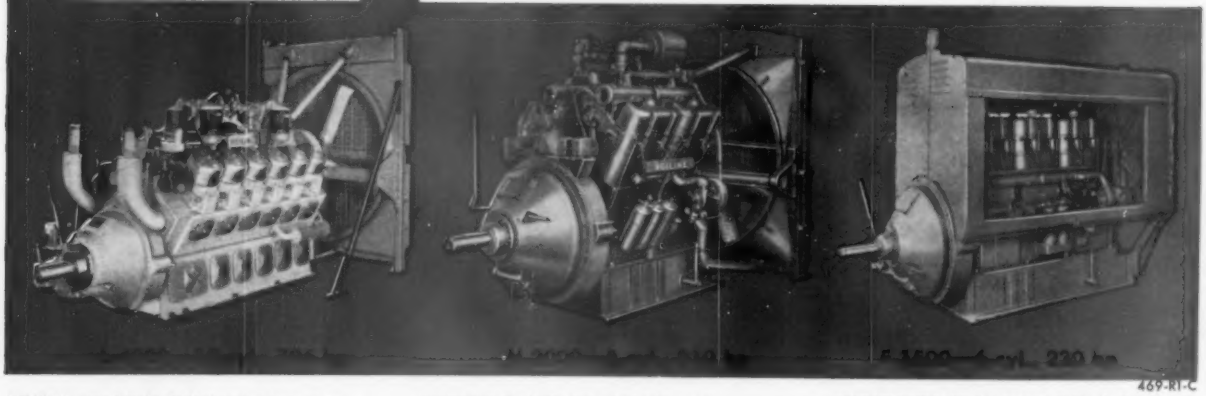


Field Processing

Transport



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Instead of one, two, or more pressure gauges to the tree, now all you need is *one gauge per gauger*. Where you would ordinarily install a gauge and valve, simply install a unibolt Gauge Valve (Fig. 2). A calibrated gauge should be inserted in an upper element, or Connector, (Fig. 1). To obtain a pressure reading, just insert the Connector in the Gauge Valve. Half a turn engages a J-slot and opens the valve, exposing the gauge to well pressure. Remove the gauge and the valve closes automatically. Since a single gauge is used for any number of wells, that gauge may be checked and calibrated frequently to insure accurate pressure readings for all wells. No gauge inventory. No breakage. No replacements. No repairs. Safe and easy to use. Stainless steel throughout.

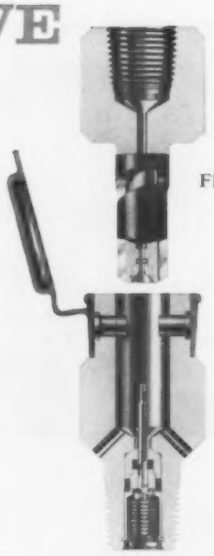

FIG. 1

FIG. 2

Connector, or upper element (Fig. 1), is attached to gauge and carried from well to well.
Gauge Valve, or lower element (Fig. 2), is installed on the tree permanently.

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A. Not too much. The risk and the magnitude of the money as compared to land rigs is so great that turnkeying is not used. Operators offshore know the contractors and seem to have a little more faith in them to operate on a day work basis.

Q. What are your thoughts regarding the adequacy or inadequacy of drilling personnel and especially in the crews and supervisory men?

A. At this time, we are not pinched for good men. We can get experienced men to work offshore because they seem to prefer the work schedules. They work 12 hours per day for seven straight days. Then, they stay ashore for seven days. For each week of work they get their salaries plus overtime, and everything over 40 hours is overtime. They make as much money in one week as they would for two weeks work on a land rig. In other words, they get 26 one-week vacations per year and work very hard for 26 weeks.

Q. Is it common to pay boat travel pay too?

A. Yes. Employees are compensated for that but at a travel time base rate, not at their normal work rate.

Q. Is there a shortage of qualified drillers or roughnecks offshore now?

A. Not at this time. It is pretty well balanced out and we're not suffering. I don't think other offshore contractors are lacking good men.

Q. How extensive is the recent movement to unionize offshore crews?

A. I don't know exactly. There is a movement under way to unionize both drilling and boat crews.

Q. From the contractor's viewpoint, what are some of the significant differences in drilling offshore as compared to conventional onshore contracting?

A. The elements are of particular significance in offshore operations. I mean by that the weather, the seas, water action, currents and things of that nature which cause the biggest trouble. Another difference is the longer supply lines needed for offshore work. For instance, you may be 100 miles from your base of operations and that 100 miles may be from a long 8 to 10 miles per hour away by boat. Long supply lines require good advance planning.

Q. Have there been any significant developments in equipment, methods or barge designs in recent years?

A. Nothing particularly unusual. There is some thought being given to submersible removable tender platforms so that a tender rig can go out with a removable tender platform floated in place with the derrick on it. If production is encountered and a well completed a permanent platform is installed. If the hole is dry, the complete unit is floated and removed.

Q. Is there any preference of type of rig power at this time for offshore rigs?

A. There is a preference for diesel-electric over anything else. I think all new offshore rigs will use diesel-electric power because it permits a better arrangement of equipment.

Q. Any new and interesting offshore developments?

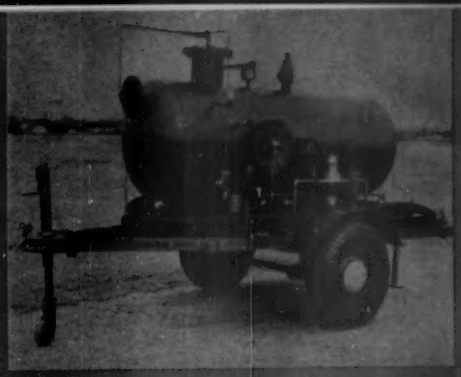
A. One item being given great consideration is underwater completions. I anticipate that within the next year or two we will see great strides in the development of equipment and techniques to complete wells underwater. We must develop this phase before we can go into extremely deep water. As we pass the 200-ft. water mark, underwater completions are more of a must. This is going to advance rapidly, and the floating drilling rig is going to have a place in extremely deep water as well as some of the big submersibles.

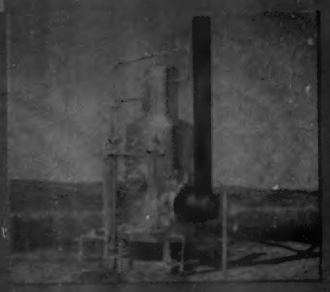
Q. What is the picture on multiple completions offshore?

A. This will continue. As in the past, there will be dual and triple completions wherever possible.

Q. What is the most popular size hole program for a single zone completion?

A. For single zone completions in the 10,000 to 12,000-ft depth range, the program would be a 10¾-in. hole for 7-in. casing. Casing programs for deeper single zones would be 13⅝-in. surface casing, a 9⅝-in. hole for 7-in. or 5½-in. casing or whatever it would take to make final completion. With multiple completions, we're going into larger casing programs. The oil string needs to be fairly large — at least 7⅝-in. if at all possible. Some may even make multiple completions in 9⅝-in. casing.





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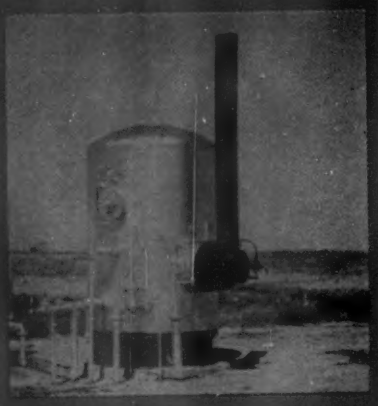
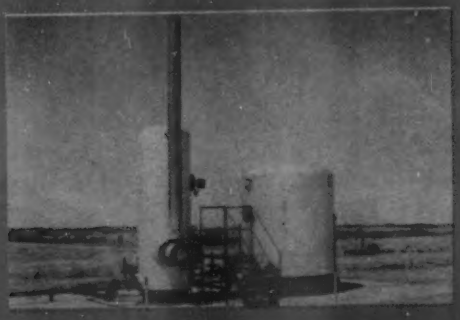
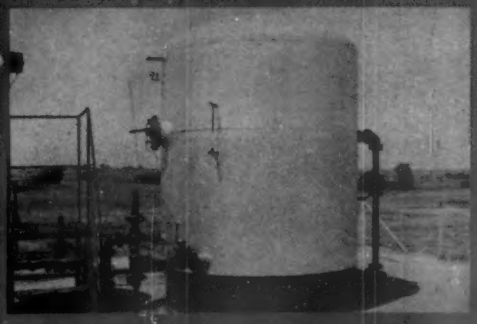
A NEW HIGH IN SERVICE AND EQUIPMENT FOR OIL-TREATING





HOIL



Now, for the first time, you can have oil-treating equipment that's designed, made, sold, and serviced by an integrated supply company. Since Hoil Equipment has joined the growing Continental team, you can have a single source of responsibility for your entire production package — from subsurface pump through LACT . . from engineering and quality control through installation and servicing.

CONTINENTAL HOIL EQUIPMENT

. . is backed by trained personnel through teams of engineers, specialists and service men available from more than 135 Continental locations.

. . offers flexibility of sizes and capacities to meet oil-treating requirements at highest efficiency.

. . lowers oil-treating costs with unitized, skid-mounted, prepiped, individualized units.

Whatever you need in oil-treating equipment... Continental's got it...worldwide

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OIL TREATING SYSTEMS

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CONTINENTAL-EMSCO COMPANY, a Division of
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General Offices: Dallas, Texas
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H11-33

HALLIBURTON FORMATION TESTING DELIVERS INFORMATION IN DEPTH

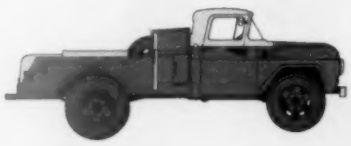
Halliburton formation tests are designed to provide the greatest amount of information possible . . . even interpretation and calculation service to help you in making the decision whether or not to complete.

Halliburton Testers are "well-site" experienced. They came up through the ranks where they learned to cope with the complexities of formation testing. Behind every Tester are the many engineers and technicians who give depth to Halliburton Formation Tests.

The proof of performance is satisfied customers. We have a long list of them, dating back to 1926, the very beginning of formation testing . . . and we invite you to join them.

Interpretation and Calculation Service
. . . another Halliburton testing advantage

TESTING SERVICES



Halliburton
COMPANY . DUNCAN, OKLAHOMA

another
TRETOLITE SERVICE
report

NEW PARID DISPERSANT CONTROLS PLUGGING DEPOSITS

To help you overcome the problems in petroleum production, transportation, and storage caused by residual hydrocarbon deposits, Tretolite research has produced a new chemical formulation with a remarkable record of success in field tests—PARID* Dispersant.

PARID is *not* a solvent. It functions, not as a solvent, but with a wetting and detergent action dependent on the presence of free water in the system treated. It is an organic compound, soluble in hydrocarbons and dispersible in fresh water or brine. It contains no carbon bisulfide, chlorinated compounds, arsenic, acetone, or other materials which can damage refinery catalysts. It is not hazardous to handle, use, or store. It will not corrode production equipment.

Available in either liquid or solid stick form, PARID effectively removes or prevents plugging deposits (of asphaltenes, bitumens, paraffins, and other substances normally insoluble in crude oil) which accumulate on rods, and in well tubing, flowlines, pipelines, and tanks.

For detailed information on application methods and specific money-saving results, ask the Man in the Red Car, or write . . .

*Trademark of Petrolite Corporation

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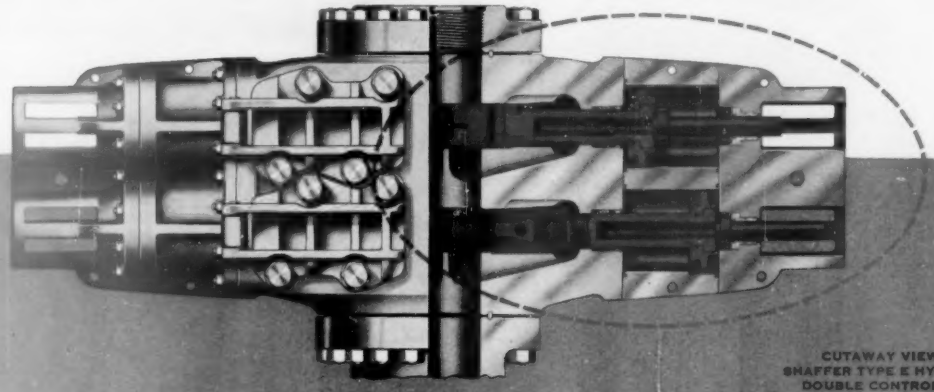
For Further Information on Advertised Products See Reader Service Card

WHEN YOU BUY BLOWOUT PREVENTERS

GET SHAFFER "IN-LINE" POWER DRIVE ...IT'S POSITIVE!



CUTAWAY VIEW OF SHAFFER TYPE E HYDRAULIC DOUBLE CONTROL GATE SHOWING "IN-LINE" POWER DRIVES

WHAT IT IS... In Shaffer Blowout Preventers there is no complicated system of levers, rods and linkages connecting the rams with the hydraulic pistons that operate them.

Instead, each Shaffer ram and its operating piston is on a *single* stainless steel shaft that is fully enclosed within the body of the Preventer. When the piston moves the ram moves. There are no complex connections to jam, freeze or otherwise jeopardize positive action!

WHY IT'S BETTER... By eliminating levers that rock, connections that rotate and exposed linkages that move, you eliminate potential trouble spots that can interfere with quick, *positive* action when emergencies threaten.

- Shaffer Preventers give you the simplest, most trouble-free ram and piston design it is possible to build—with both the ram and its operating piston on a *single* shaft—and no complicated connections in between!
- Pressure seals are also reduced to a minimum because far fewer seals are required. And any time you eliminate seals you reduce maintenance, as well as possible problems, when high well pressures are encountered.
- Shaffer's design also means elimination of connections that require frequent oiling or greasing... elimination of exposed operating parts that can become corroded by chemical-laden muds or well-treating fluids... elimination of levers or yokes that can become jammed by loose boards, pieces of pipe, or other objects falling from the rig floor.

RESULT... When pressure emergencies threaten the safety of your well, Shaffer Blowout Preventers provide unequalled assurance of *positive* ram operation... and this is just one of the many "plus" advantages built into *every* Shaffer Blowout Preventer!*

THERE'S A SHAFFER BLOWOUT PREVENTER FOR YOUR PARTICULAR REQUIREMENT!

TYPE B and TYPE E Preventers are the units selected for most drilling applications. Type B has *non-rising* Locking Shafts for maximum compactness... Type E has *rising* Locking Shafts for quick ram indication.

TYPE XHP Preventers are ideal where extra-high well pressures are a problem. Each XHP unit is individually tested to 15,000 PSI *Working* Pressure in 7 1/16" Bore Size... to 10,000 PSI *Working* Pressure in 9" and 11" Bore Sizes.

TYPE LWS Preventers combine lightweight with adequate pressure rating for a wide range of applications. LWS units weigh approximately *half* as much as other Preventers of comparable size.

The above Preventers (except Type XHP) are available in choice of *Double* units *(two* Preventers unitized into one compact body for maximum space-saving)—or *Single* units.

See your nearest Shaffer representative for complete details. Or write direct!

*OTHER SALIENT SHAFFER ADVANTAGES...

- "Swing-Open" Doors for Quick Ram Changes!
- Space-Saving Compactness!
- Self-Cleaning Ram Compartments!
- Completely Enclosed Construction!
- "Floating" Ram Design!

...and still others your Shaffer representative will gladly explain to you!

38 years OF OIL TOOL LEADERSHIP

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

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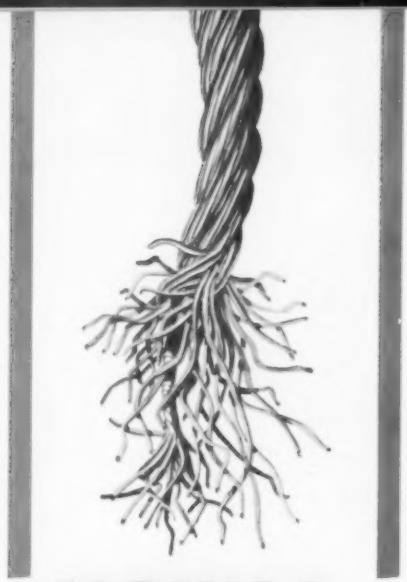
NOWSCO Nitrogen cuts completion cost – Job #1712



YOU'LL NEVER LOSE ANOTHER SWAB!

(You won't even use one!)

No need for swabbing when NOWSCO brings your well in.

When this Texas offshore wildcat (see diagram) was completed to two gas zones, the contractor took no chances on blowouts or fishing. He called NOWSCO.

Barged out to the drilling rig at 5:30 AM, the NOWSCO serviceman hooked up and had pressure on the lower completion within 15 minutes! Injecting nitrogen at 3500 psi, he displaced all 8900 ft. of lower-string fluid in 1 hour, then displaced 5000 ft. of the upper string in 35 minutes. Well was brought in by controlled bleeding to atmosphere. *Total time – 2½ hours. Total cost – $740!* In addition:

- Gas flow began several hours sooner
- Saved several hours of expensive rig time
- Saved possible scarring of plastic coated tubing by swab cable
- Eliminated possible swab loss
- No chance of blowout

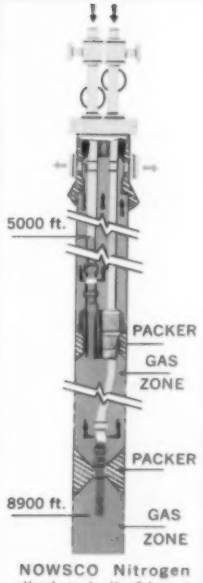
Nitrogen techniques by NOWSCO save money in many other ways – increase penetration of hydraulic perforating, provide inert gas bubbles to push frac fluids and spent acids out of formation, quickly lighten mud column to combat lost circulation, test pressure-tightness more sensitively than with fluid, prevent downhole explosions when gas drilling through pay formations.

NOWSCO Nitrogen comes to your site night or day, in self-contained transport-pump trucks. NOWSCO servicemen are veteran oil field workers thoroughly trained in nitrogen techniques. Backed by more than 1700 cost-saving NOWSCO jobs, they're ready to service your wells with individually calculated injection rates, pressures, volumes.

Want the NOWSCO story on your field conditions? Write or call today for on-the-job case histories.

NOWSCO offers the only complete liquid nitrogen service . . . from manufacture through field application.

NOWSCO service trucks and operators are on 24-hour ready at Houston, Corpus Christi, Perrytown, Odessa, Orange and Lafayette, La.



NOWSCO Nitrogen displaced all of lower string and 5000 ft. of upper string, as shown. Both were brought in by bleeding Nitrogen to atmosphere.

Originator and prime authority on liquid nitrogen techniques . . .

NOWSCO N_2

NITROGEN OIL WELL SERVICE COMPANY
3602 West 11th Street, Houston, Texas
Telephone: UN 4-0965

N E W—from Johnston Testers

INSIGHT

ANALYSIS OF DST DATA

to give you a
sharper view of
the subsurface . . .

. . . engineered by the people who invented drill stem testing and brought the art to its present state of perfection.

This new, deep-penetrating Engineering Analysis facilitates computation of hydro-dynamics, provides indicated permeability and presents an analysis of well bore damage.

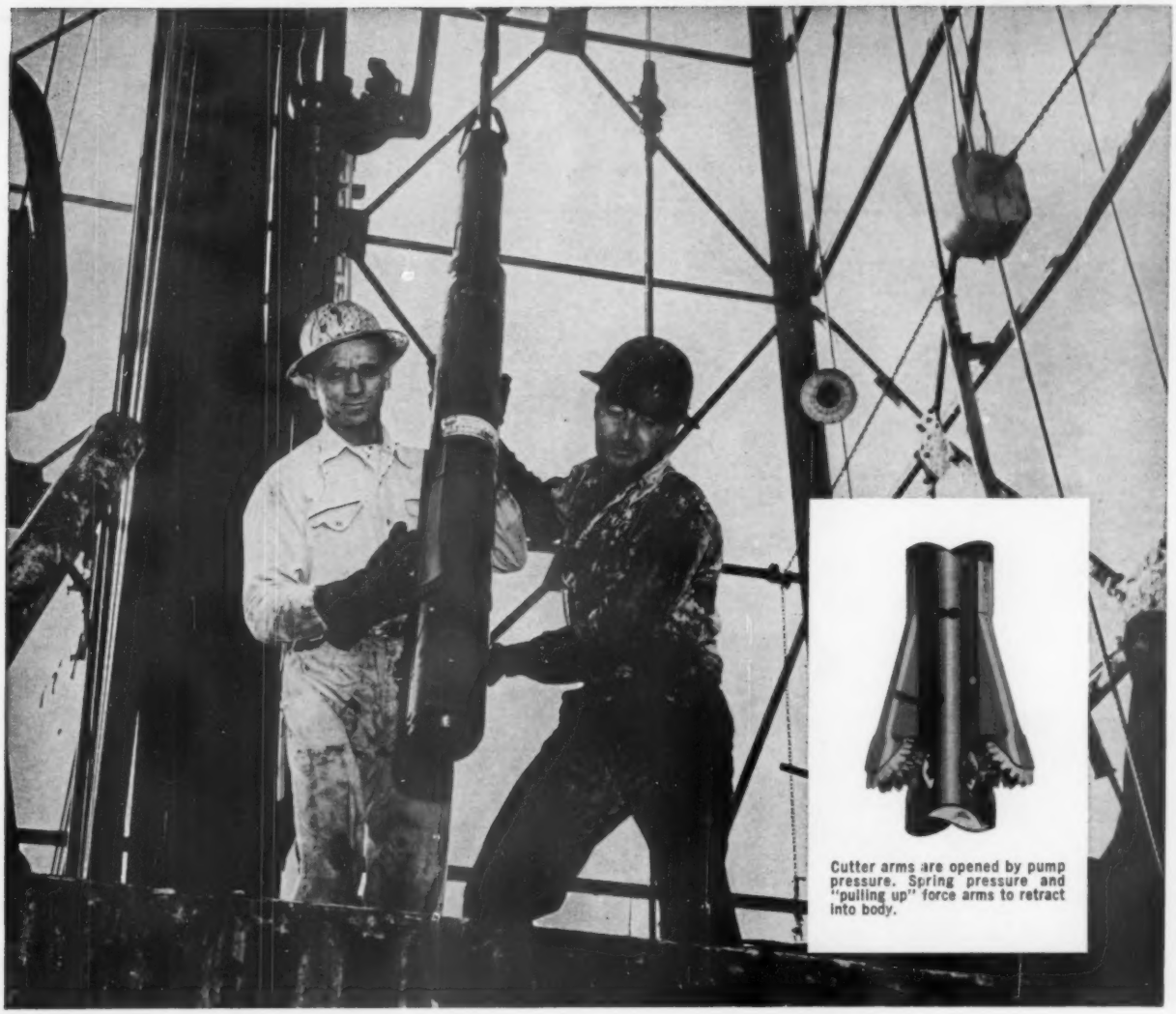
At modest cost, this comprehensive report will relieve your engineering staff of laborious detail work. You will find **Insight Analysis** invaluable in avoiding the risk of passing up a producer.

For more information about this new service, call Johnston Testers in your area, or write:

A WORLD OF EXPERIENCE

JOHNSTON TESTERS

HOUSTON, TEXAS
CALGARY, CANADA



Cutter arms are opened by pump pressure. Spring pressure and "pulling up" force arms to retract into body.

New Servco Hole Opener drills like a rock bit ...opens hole up to 3 times faster!

- Enlarges hole up to twice the drilled diameter in hard or soft formation.
- Positive opening by direct pump pressure.
- Full volume circulation at all times.
- Choice of fluid flow—substantially through the pilot or entirely through cone recesses.
- Choice of cones for the most efficient cutting.
- Simple, rugged construction. A minimum of parts insures trouble-free operation.

Just a casual look at the new Servco Expandable Hole Opener tells you it's a *simple,* rugged tool, built to take a lot of hard downhole use. A closer look reveals the secret of its exceptionally fast penetration—the use of *rock bit-style* cones. In operation, the Servco Hole Opener drills like a rock bit. Actual job records show holes can be opened (up to twice the drilled diameter) three times faster than with conventional hole openers. Cementing, gravel packing... any casing clearance operation... can be completed faster and more effectively, resulting in important rig-time savings.

Call your Servco field man on your next hole opening job. He'll be glad to work with you to get the maximum results.

SERVCO
...the modern drilling tools

General Offices: 2440 Cerritos Ave., Long Beach 6, California
Canada: 6909 104th St., Edmonton, Alberta • **Venezuela:** Apartado 198, Maracaibo
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The "OILWELL" string...

PRODUCTS
SERVICES
STORES

Here's why "Oilwell" Century Pumping Units pay dividends

There's always a reason for success. In the case of our Century Pumping Units, the reason is as plain as day: we designed them *after* we surveyed operators to find out what they wanted in pumping units. They asked for dependability, economy, simplicity and safety. We gave it to them in these outstanding Century features:

Their *dependability* comes from the primary structural elements being rigidly welded and perfectly aligned with front samson post legs widely spaced on a solid, T-shaped base. Their *economy* comes from wearing parts engineered for *heavy-duty* service. Their *simplicity* and *convenience* in well servicing comes from an easy-to-roll-back arc with automatic latch, and from a one-piece slant-slot yoke. Ease of care and operation comes from the fact that routine maintenance can be done at ground level. *Safety* comes from the Type G Cranks that make maximum use of counterweights and are easy to adjust with the operator working safely to the side of the unit . . . with lots of toe room between weights and floor.

From design theory to the smallest actual details, Century Pumping Units are the most modern, most efficient available. For full information, write or ask for a free copy of our descriptive booklet 27-61.

USS and "Oilwell" are registered trademarks

The service is great in The Pump Room

It's a different sort of menu than you'll find in Chicago's famous Pump Room, but you can't beat "Oilwell" pump shop service anywhere. Every "Oilwell" pump shop is staffed with specialists who have a background of technical and operating experience. They're there to help you with your pump problems, whether it's pump selection, maintenance, or reworking. On certain pumps, such as SPUN METAL sectional liner subsurface barrels, "Oilwell" offers an *exchange service* that gives you an indentical reworked barrel at less than half its original cost. No matter what your pump problem is, take it to the nearest "Oilwell" pump shop where you'll get the superior service that comes with every "Oilwell" product you buy.

Meet Don O'Bryan

Don is the "Oilwell" store manager in Houston, and he has the background it takes to help you with your problems. He's been with "Oilwell" 28 years, and he knows the oil business inside and out.

Every "Oilwell" store manager is there to see that you get what you need—emergency-fast when necessary. From pumping unit and prime mover to the perforated nipple on the bottom of your tubing string, "Oilwell" stores are stocked with top quality producing equipment in the types and sizes that are locally popular. They carry everything you need from the hundred-and-one fittings, small tools and miscellaneous hardware to flashlight batteries and wiping rags. And store men like Don O'Bryan have access to the knowledge and up-to-the minute information to help you on practically any equipment problem. That's a good reason for stopping by your "Oilwell" store.

USS Oil Well Supply Division of United States Steel

Executive and Export Offices: Dallas, Texas

Stamp Of Approval —WORLDWIDE

In the short span of three years, Wilson Supply International Division has received the stamp of approval for its service to oil producers around the world.

Oil men have found the Wilson Supply International offices in Houston and New York staffed with veteran supply men, experienced in handling equipment needs for overseas operations. At the other end of the line, the Wilson Supply International representatives have an earned reputation for expediting equipment, rendering fast field service.

Maintenance supplies or a complete drilling rig . . . your Wilson Supply International representative will get you *what* you want . . . *when* you want it. That has been the byword of Wilson Supply operations for 40 years. Write for catalog information on the complete lines represented by Wilson Supply International.

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INTERNATIONAL DIVISION

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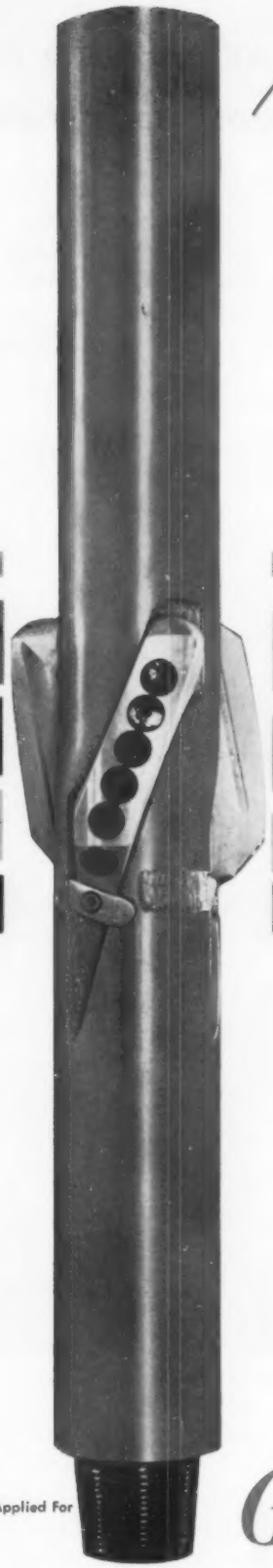
Oil & Gas Supplies • Tubular Goods • Production Equipment • Drilling Machinery • Packaged Compressors • Fishing Tools

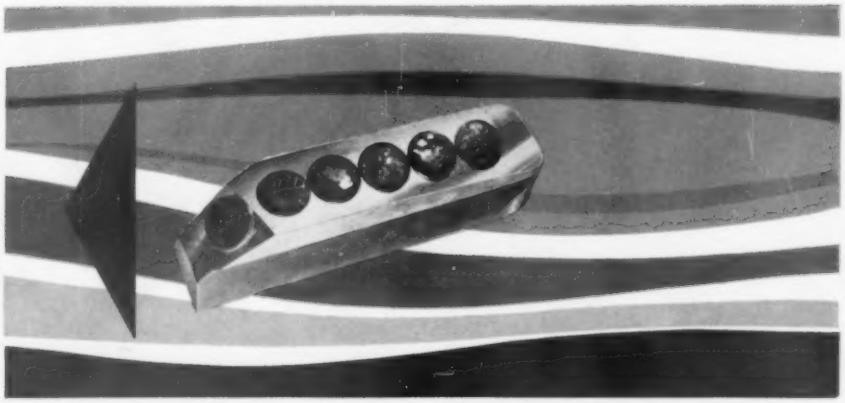
102

New Safety... New Economy...

from GRANT in the BUTTON DRILBLADE STABILIZER!

Now—to the *economy* of drill string stabilization with Grant detachable blade stabilizers—you can add *greater safety than ever before.*





Grant's entirely new concept in blade design is this all-new Button Drilblade* of forged and heat-treated aluminum with press-fitted, individually hard-faced, mild steel inserts. ***It cannot break off or come loose in the hole.***

Longer downhole life of the all-new Button Drilblade is achieved by thicker application of tungsten carbide, made possible by the cupped design of the insert heads. Also, a new type of rod delivers a higher percentage of the hard metal to the bearing surface.

Tensile strength and density of the forged aluminum blade body is further strengthened by the press-fitted steel inserts. Thus, neither the blade nor the inserts can work loose or break off. Yet the blades are easily washed over. Drilblades are retained in the Stabilizer body by tapered slots, engineered so that the blade is actually tightened during use, and by Double-Safety Lock Plates. Removal of Lock Plates permits the blades to be easily changed on the rig floor.

The Grant Drilblade Stabilizer—already the preferred tool for directional drilling all over the world—is now the most dependable tool available for this work.

The new Button Drilblade is fully interchangeable with Grant standard blades. It is available in all body sizes 'round-the-clock from your Grant service man—or write Grant direct for specifications and prices.

*Patent Applied For

GRANT OIL TOOL COMPANY

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SIMPLIFY TREE CONSTRUCTION . . . AT LOWER COST

W-K-M Cross Type Multiple Completion Gate Valves

These compact multiple gate valves cost less than equivalent components and provide all of the service-proved features of regular W-K-M ® Gate Valves such as non-lubricated operation, Teflon* seat inserts for double-tight sealing, and parallel expanding gates for a positive up and downstream seal.

W-K-M Cross Type Gate Valves are available for dual, triple and quadruple completions. Specify W-K-M — at leading supply stores everywhere. Write for Catalog 200. W-K-M Division of ACF Industries, Inc. P. O. Box 2117, Houston, Texas.

*DuPont's tetrafluorethylene resin

When So Much Depends on a Valve . . . Specify W-K-M.

W-K-M DIVISION

ACF INDUSTRIES

QA QA QA QA QA QA

"Activity has been up . . . and as far as we can see, it looks very good"

WALTER KALTEYER
Vice president and general manager, Hunt Drilling Co., Corpus Christi, Texas.

Q. What is the area your operations cover?

A. Virtually all the Texas Gulf Coast, in Railroad Commission Districts 2, 3 and 4.

Q. How has activity been there this year?

A. This year has been very good for us, and I would say that our company experience probably reflects the industry here.

Q. Is activity in your area up or down compared to last year?

A. Up. Some of it has been due to an accelerated program by one major producer who had 35 rigs running at one time.

Q. How does the picture look for next year in your area?

A. As far as we can see, it looks very good. We are receiving more and more bid requests and I think that indicates better business.

Q. What seem to be some of the controlling factors as to whether drilling is up or down?

A. Principally the international situation. Our producing allowable days haven't changed considerably. It looks like they are pretty well set at a low figure of 8 to 10 days. I would think it's the future demand the operators anticipate that influences their drilling programs.

Q. Has gas been a factor?

A. Of course. This has been an active gas area but that has been going on for three years. People still drill for oil.

Q. Would you say operators are in a little better shape now than two years ago?

A. I think they are because they have gone through their operations on an economy drive. As a result their profits look better, and when their profits look better I think they are more apt to do more development work.

Q. Do you have more drilling by independents or majors in your area?

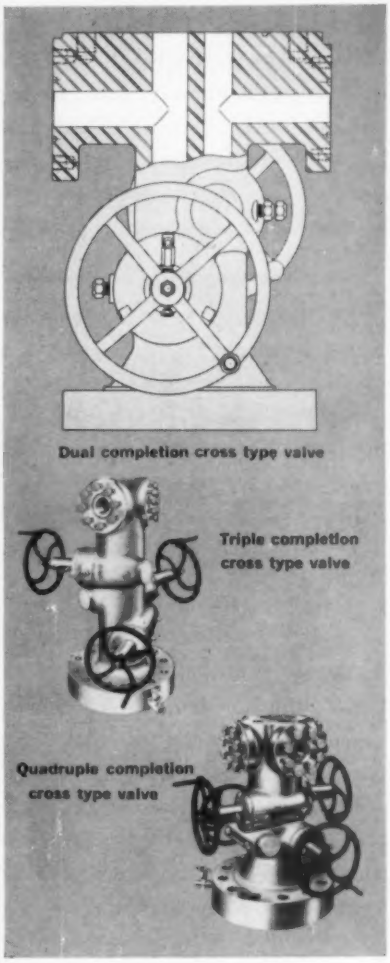
A. The majority of our work is for major companies. Of course, we operate just five rigs and they're usually taken up by majors. Independents do a great deal of the drilling down here.

Q. What are your thoughts on the adequacy or inadequacy of drilling personnel, especially the crews and field supervision?

A. We suffer a great deal from concentrated industrial development in this area. Petrochemical

W-K-M
Multiple-Completion Valves

W-K-M Multiple-Completion Valves are built with Teflon seat inserts for dead-tight sealing, pressure-seal bonnets, superfinished stems equipped with roller bearings, and sealing surfaces protected from the flow.
Sizes: 1¾" and 2"
Working pressures: 2000, 3000, and 5000 lbs.



W-K-M DIVISION
ACF INDUSTRIES

NEW CONCEPT IN EMULSION TREATING

combines **PETRECO** *Electric Precipitation with* **TRET•O•LITE** *Chemicals*

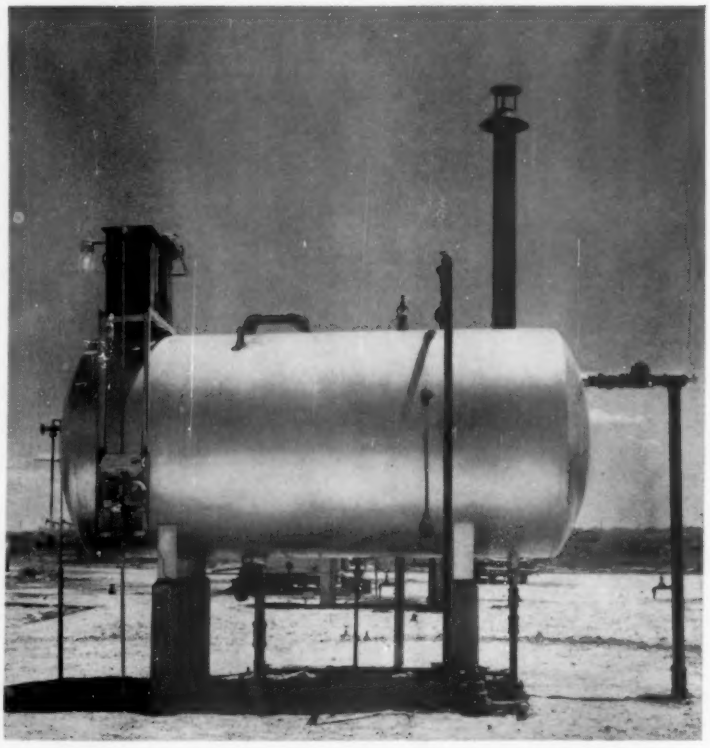
Carefully engineered to offer petroleum producers a new concept in crude oil emulsion-breaking performance, the new PETRECO* Chemelectric Treater blends the time-proved effectiveness of PETRECO electric precipitation and TRET-O-LITE* chemical demulsification . . . the vapor conservation of a closed pressure vessel . . . and the added utility and economy of a built-in low-pressure de-gassing section.

Requires Little or No Heat

By eliminating the usual demulsifying heat requirement, and by treating in a vapor-tight pressure vessel, the light ends are conserved, true A.P.I. gravity is maintained, and volume losses from vaporization are avoided. You have more crude to sell, at a higher price. The easily-installed, fully-automatic PETRECO Chemelectric Treater also saves fuel and minimizes scale and corrosion problems.

Doubled Throughput

In field operation on a West Texas lease, one 6′ PETRECO Treater dehydrated over twice as much oil in a given time as did a 6′ thermochemical unit and did so at an 85°F. lower temperature. Water content of the PETRECO-treated crude was 50% less. Basic sediment was reduced from .2% to zero. A.P.I. gravity averaged 1.1 points higher.



*Registered trademark, Petrolite Corporation

The cost of this unique new equipment is less per installed barrel of capacity than old-style systems. The PETRECO Chemelectric Treater requires no more chemical than for conventional treating and normally consumes less than 1 KW/hr. of electricity. For further information or a specific quotation, write or call . . .

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PETRECO DIVISION
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CE-61-1

UNAFLO OIL-WELL CEMENT

compatible with additives for slurry weight control

Another field report proves Unaflo oil-well cement compatible with additives for light- or heavy-weight slurries ranging from 12 to 19 lbs./gal.

For cementing casing or liner, squeeze cementing, plug-backs or recementing, UNAFLO cement slurries pump easily and set hard to provide an adequate seal. Its retarded set sustains high fluidity despite high temperatures and pressures. This allows time for proper placement plus a margin of safety for delays or emergencies.

For more information, write Universal Atlas Cement, 100 Park Avenue, New York 17, N. Y.

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Universal Atlas Cement
Division of
United States Steel

CEMENTING DATA

Contractor: Rowan Drilling Co., Inc., Ft. Worth, Texas

Job #1 – String of 9⅝" O.D. -N80 and P110 casing run in a 12¼" hole to 14,095', cemented with 1,500 cu. ft. of lt. wt. slurry composition (811 sacks UNAFLO plus 406 cu. ft. Stratacrete 6 plus 4% gel by weight of cement). Slurry wt. 13.3 lbs./gal. Drilling mud wt. 11.8 lbs./gal Log temp. 216°F. Est. static BHT 248°F. Final pressure 2,000 psi. Full returns accomplished during 1 hr. and 40 minutes mixing and pumping of the slurry to place behind the pipe.

Job #2 – Drilling 8⅜" hole below 9⅝" casing at 14,483' using 17.9 mud, well started losing mud and kicking. Retrievable-type packer set in the 9⅝" casing at 14,006' and the open hole was squeezed using 1,000 sacks of UNAFLO plus .3 of 1% HR4 Retarder. Max. squeeze pressure of 5,200 psi resulted with 825 sacks out in the formation. Mixing and pumping time 2 hrs. and 7 minutes. Est. static BHT 276°F.

Job #3 – 856' of 6⅝" O.D. P110 liner bottomed at 14,895', cemented with 250 cu. ft. of a weighted slurry composition consisting of 205 sacks UNAFLO cement plus 8,000 lbs. Ilmenite Ore plus .3 of 1% HR4 by weight of cement. Drilling mud weight 18.5 lb. gal. Log. temp. 245°F. Est. static BHT 282°F. Full returns accomplished during 55 minutes mixing and pumping of the slurry.

For Further Information on Advertised Products See Reader Service Card

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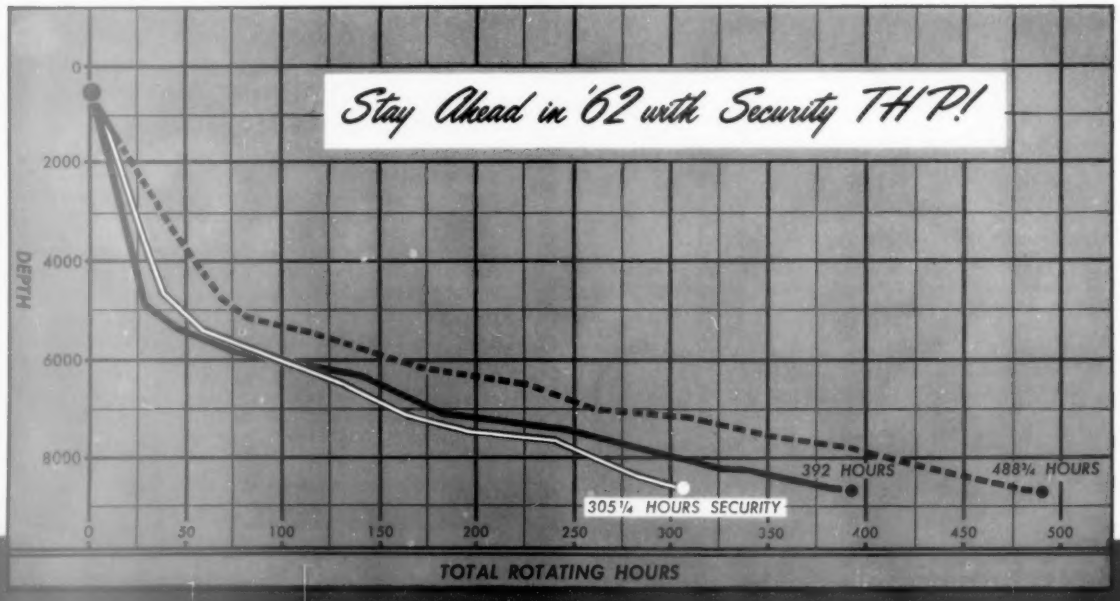
TO CUT COST-PER

Through Security's *total hole program* – THP... using Security bits all the way... you are assured of less cost-per-foot than in any 100% NON-SECURITY hole — with similar drilling conditions. Security assistance is available for engineering your drilling program.

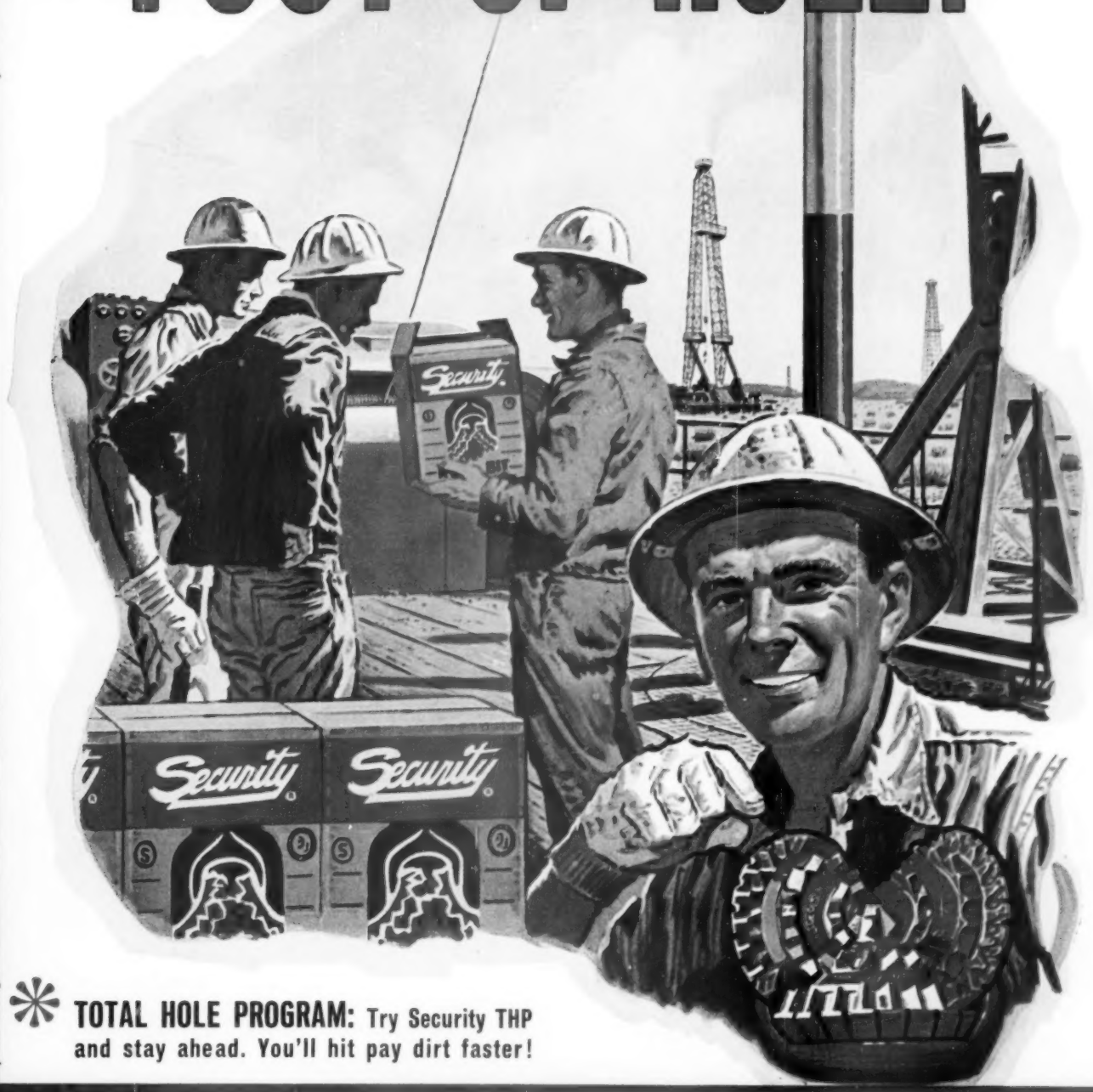
Security challenges drillers world-wide to try the Security total hole program concept. Using Security bits all the way cuts costs ... increases penetration rates... contractor profits go up! Security's modern plant, quality manufacturing and years-ahead engineering-research combine to create the finest bits in the world today.

Check these Performance Per Foot Facts!



SHOWN ABOVE: Actual comparison with [illegible] best offset holes... non-Security bits vs. a 100% Security hole using THP. Check the overall [illegible] foot compared with the next best offset hole above.

Challenge With thp*
-FOOT OF HOLE!



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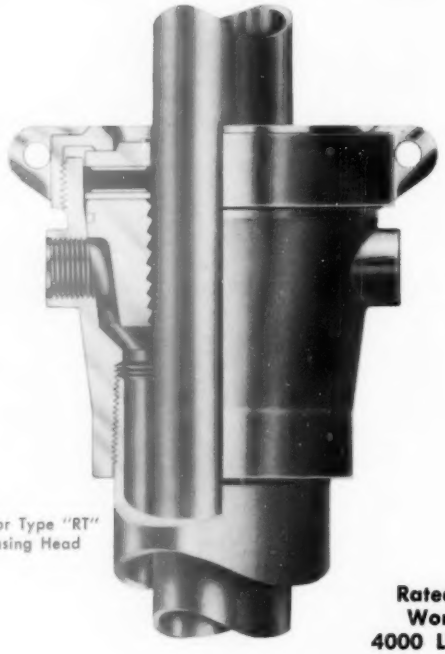
DRESSER INDUSTRIES, INC.

Rector
Non-Flanged Tubing and Casing Heads



Rector Type "RT" Casing Head

Rector Type "R" Tubing Head

Rated at 2000 Lbs. Working Pressure
4000 Lbs. Test Pressure

Quality at Low Cost

For trouble free service at lowest cost you can depend on RECTOR non-flanged well head equipment. Constructed from pre-tested steel alloy to meet exacting engineering specifications, RECTOR non-flanged tubing heads and casing heads are designed to satisfy the widest range of producing conditions economically.

CHECK THESE IMPORTANT FEATURES

SUSPENSION – Casing heads have case-hardened three-segment type *hinged* slips of ribbed construction to allow full flow to outlets. Tubing heads use same or threaded type of suspension. A special threaded or slip-type mandrel hanger is also available for use with Kobe pump or dual string tubing completion.

SEAL — Both casing and tubing heads have an oil-resistant pack-off which is forced into sealing position by a split packing gland tightened by a cap threaded to the body.

SIDE OUTLETS – Both casing and tubing heads are available with 2", 2½" or 3" threaded side outlets.

BOTTOM CONNECTIONS – Casing heads have male or female threaded bottom connections. Type "RT" is available through 10¾". Type "R" tubing heads are available with male or female threaded bottom, 4½" through 7", also all flange sizes and series with standard API ring groove and bolting arrangement.

Rector casing and tubing heads are available through your favorite supply store.
For more information see your Rector representative.

MONOGRAMMED EQUIPMENT CERTIFICATE NO. 2158

Rector

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Making the Oil Industry Safer!

PESA

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EXPORT REPRESENTATIVES: CONTINENTAL-EMSCO CO., MID-CONTINENT SUPPLY CO., OILWELL DIVISION OF UNITED STATES STEEL CORPORATION

plants have taken drilling personnel because they pay much higher scales than we can afford. Not only is the worker's take-home pay bigger, but he participates in elaborate fringe benefit programs. It makes it pretty hard to keep good crews, and we are constantly looking for ways to make our company more attractive to available experienced drilling personnel so they will stay with us. We do not have fringe benefits at the present time and we are not in favor of going on a 40-hour week because of attendant problems. We will get into items like paid vacations; also perhaps a bonus of some sort for our key people. We do have bonuses for tool pushers but it looks like we soon will include drillers.

Q. Is there any indication in your area of efforts by unions to organize drilling crews?

A. No. Not in our area.

Q. Have you noticed any difference in recent years in the contractor-operator relationship?

A. We think producers are more demanding than in previous years. If they want to make more demands, we feel our pay schedules will have to be changed. If producers want the contractor to take on more responsibility, they must be willing to pay for it. Producers today are looking very closely at their contracts. Formerly, a company field man would handle some of the incidentals at their expense. Now, people far removed from the operating departments examine and approve or disapprove certain charges.

Q. Do you have any ideas or thoughts about improving this relationship for the benefit of both parties?

A. We find that some operator personnel making decisions are not well enough versed in field operations and make demands which we think are sometimes a little unreasonable. I don't know what we can do about that except to show our problems to the operators. The operators don't want to go back into operating company rigs because contractors can do this much more cheaply. We still find some companies who send in bid sheets with virtually no information on them. You may bid on a job without benefit of all details, and after you are down 3000 or 4000 ft you finally get a contract and find you are obligated to do a great many things not previously outlined. We think the best way to send out

"Triple Threat"
TO SUCKER ROD FATIGUE
1. JONES SUCKER RODS
2. JONES UNDERCUT PINS
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1
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Rolled threads are stronger at the point where most pin failures originate . . . steel fibers and grain are rearranged to follow the thread contour, providing a dense structure at the critical thread root. Sucker rods with rolled threads make up tighter and stay tight because there are no high spots to beat down and cause the joint to loosen.
Undercutting the pin shank further increases fatigue resistance by eliminating the run-out thread and improving the elasticity of the joint.
Ask your Jones representative for further information on the "Triple Threat".
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SUCKER RODS

QA QA QA QA QA QA

bid invitations is in the form of a complete contract which is also a bid. When the contractor makes his bid on this contract form and it is accepted, the bid automatically becomes the contract.

Q. Any trend to turnkey work?

A. Not among the majors especially. Some of the smaller operators who put deals together prefer some type turnkey work.

Q. Do you think there is any practical answer to the critical problem of cutthroat bidding?

A. It seems to be a matter of supply and demand. In some cases where payments are due on a rig, a contractor may take off a dime per ft because he would rather loose 10¢ a ft than have a rig down. A better balance between rig availability and rig demand should cure such practices.

Q. What steps can a contractor take to combat the economic squeeze?

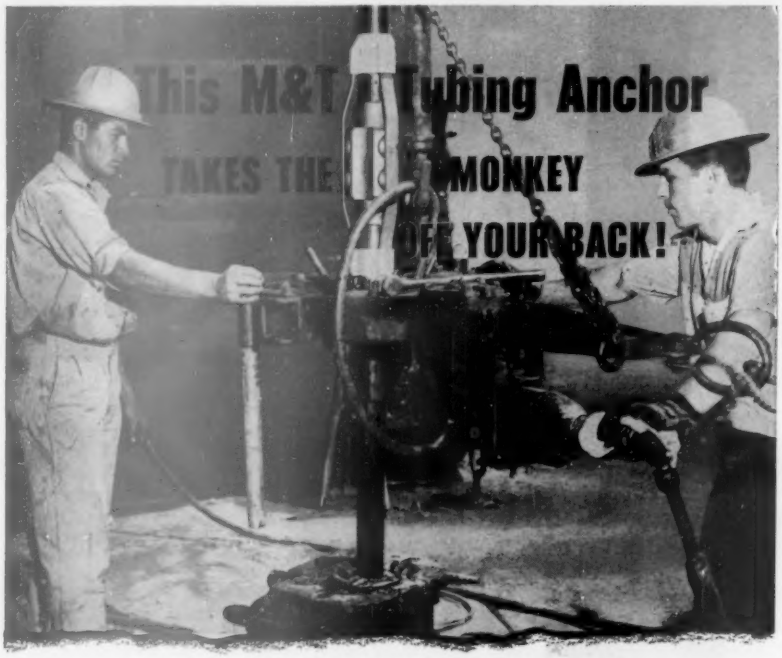
A. About all you can do is try to sell quality. The contractor is the only person in the drilling industry who has to compete on both quality and price. Operators who sell gasoline do not compete on price. Prices are all the same. So they advertise quality. We can get a cat tractor for $15.40 per hr from anyone, but we can't get one for $14.75 per hr. A 16-ton tandem truck cost $16 per hour — no less. A piece of pipe or a sack of cement or a roughneck — anything we buy or anyone who serves us or who serves the operator — has a fixed price. Those people compete only on quality, whereas the contractor for some reason must compete on quality and price.

Q. Has there been any trend toward emphasizing quality rather than price?

A. We try to talk it up but many operators do not take it seriously, some still look at price only. They will pay $725 per day but won't pay $750 for a small rig, even though $750 a day might be able to save them an hour on every trip, which would more than make up for the difference. We try to stress that what the operator really should look for overall is the most economical price per foot, whereas in many cases, we think he just looks for the lowest price per foot.

Q. Have you noticed any trend or indication that contractors have done comparable things to reduce their costs and streamline their organizations like some of the producers have?

A. Yes, we think they have. We know we have. We are looking much more closely at our costs



What does that mean? It means you've got more time for other duties, because the M&T Compensating Frictional Tubing Anchor can be run by your own crew without your supervision.

Oh, sure, and they'd run it upside-down! No matter. The M&T Anchor works with equal effectiveness either way. Just run it in the hole and start the pump. That sets the anchor. Positively. Pressure does the work. *And* — no wickers to damage casing.

H'm. How do you get it out again? No trouble there, either. Unseating the pump releases the M&T Anchor. You can move it or pull it at any time, under any conditions . . . wet or dry . . . no bleeder valve needed . . . no risk of a costly fishing job.

Sounds good. How about maintenance? The lowest! 1,300 M&T Tubing Anchors are currently at work in the oilpatch, with less than 2% maintenance. M&T dependability holds costs down!

You can get more info from your McGaffey-Taylor or Eastman Oil Well Survey field man . . . today!

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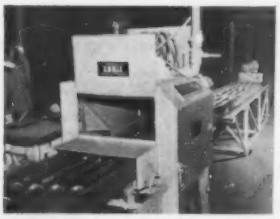

With AUTOMATION . . . press a button, Rods Rotated and Passed through Sand Blaster completely Automatically.

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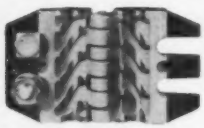

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QA QA QA QA QA QA

now, especially organization and purchasing and our books reflect considerable success in our cost reduction program.

Q. Are there any operating or equipment improvements you think we need to make?

A. Many people have made changes in certain operations such as mixing mud. Instead of using a piston pump, they use centrifugal pumps, utilizing volume instead of pressure. And, a centrifugal pump costs less than fluid end parts on a big piston-type mud pump. Aluminum drill pipe with steel tool joints should extend the depth to which a rig can be taken and make it cheaper to drill a deeper hole. I believe we will soon get rotary speeds, weight on the bit and pump pressures down to a practical point.

Q. Any air/gas drilling on Texas Gulf Coast?

A. There is very little air drilling here due to excessive surface water.

Q. What are some conventional hole sizes in your area for a 10,000-ft well?

A. The smallest normal hole is 8¾ in. except that at depths shallower, 8500 or 9000 ft, it would be 7⅞-in.

Q. Is there any trend toward multiple completions in your area?

A. Very much. We have completed probably 50 or 60 wells where as many as four strings of casing were run. We drilled the Sunray well which was the first quintuple completion. ■

WHEN YOU ENCOUNTER EXCESSIVE TORQUE, DRAG OR THE HAZARD OF STICKING DRILL PIPE AND CASING . . . .

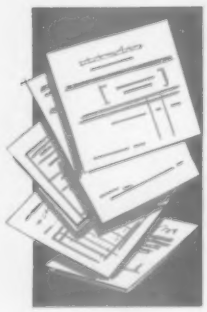
SOUTHWESTERN **92** FLAKE GRAPHITE

excellent dry lubricant • inert • compatible with any mud • mud rheology unaffected • mixes readily • inexpensive • minimum graphitic carbon 92% • durable, weather-resistant 50-lb. bags

SOUTHWESTERN GRAPHITE COMPANY
GRAPHITE ROAD • BURNET, TEXAS

4 REASONS WHY MILK EMULSIONS REDUCE DRILLING COSTS IN HARD ROCK

Milk emulsions have saved thousands of dollars for contractors and operators drilling in the hard rock areas. Well records reflect a consistently lower cost per foot drilled where emulsions are used.

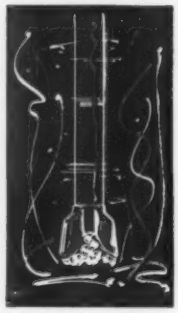


1. Lower Mud Bill

With milk emulsion drilling fluids mud bills are generally equal to or lower than a comparable type mud system. Less material is required and drayage is reduced. Milk emulsions are less susceptible to contamination — require fewer chemicals. Speed and ease of mud-up (one circulation), maintenance and fewer days on the well save money. Result — reduced drilling costs.

2. Faster Penetration

Milk emulsions oil plate cuttings preventing hydration and solids build-up. These result in fewer days on the hole and lower over-all costs. Low viscosity, plastic viscosity and yield point reduce friction loss and make a higher percentage of the horsepower available at the bit. Better lubrication permits more weight on the bit. Result — reduced drilling costs.



What are Milk Emulsions?

Milk emulsions are low-solids drilling fluids—water containing 5% oil and an emulsifier such as Trimulso, Drilling Milk or Atlosol.

3. Increased Bit Life

Longer bit life means fewer trips to change bits. Since each trip takes significant time, this sharply reduces over-all costs — both from the cost of the bits and the reduction in round trips. Oil wetting action of the emulsifier lubricates bit bearings and keeps bits clean—prevents balling. Result—reduced drilling costs.

4. Less Trouble

Lower hydrostatic head and lower circulating density reduce lost circulation problems —maintain truer gage hole. Thinner filter cake doesn't restrict circulation—lets hydraulics operate as set up. Oil wetting of everything in the hole avoids differential sticking. Result—reduced drilling costs.

In addition to lower costs, other benefits of using emulsions made with Atlas emulsifier include better geological samples, better hole condition and faster penetration.

Atlas emulsifier is sold through distributors under the following tradenames . . . each is the product of Aquaness Department, Atlas Chemical Industries, Inc:

TRIMULSO® distributed by Baroid Division, National Lead Company.

Registered trademark Baroid Division, National Lead Company.

DRILLING MILK® distributed by Magnet Cove Barium Corporation.

Registered trademark Magnet Cove Barium Corporation.

ATLOSOL® distributed by Milwhite Mud Sales Company and other selected mud companies.

Registered trademark Atlas Chemical Industries, Inc.

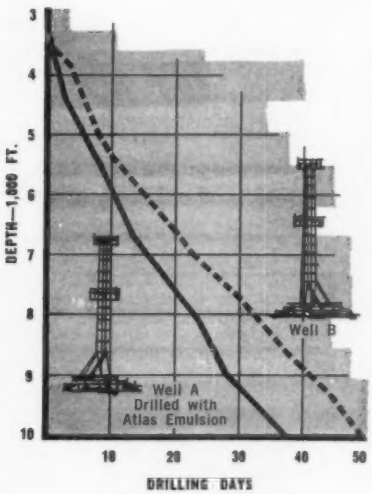
Aquaness
DEPARTMENT
ATLAS CHEMICAL INDUSTRIES, INC.

Atlas Emulsifier Saves $16,823 On Loco Hills Well

Drilling Record Comparison

	WELL A	WELL B
Mud	Atlosol Emulsion	Low Solids CMC
Interval	3,484'-10,000'	3,500'-10,000'
Hole Size	8¾"	8¾"
Drilling Days	37	50
Feet per Day	176	130
Bits Used	53	67
Feet per Bit	123	97

A direct comparison of two wells in the Loco Hills area of New Mexico shows savings typical of those realized when drilling with milk emulsion. Both wells were drilled with rigs of comparable horsepower and hydraulic capacity. Hole size and formation drilled were identical. Well A utilized a milk emulsion made with ATLOSOL, an Atlas emulsifier. Well B used a low-solids CMC mud throughout the comparison interval (3,500 to 10,000 feet).



Well A showed a net saving of $16,823. This saving was made as the result of faster penetration and extended bit life. Thirteen fewer days on the well and fourteen fewer bits reduced the cost per foot by $2.59.

Ask the Aquaness drilling specialist for complete information on all the benefits of Atlas milk emulsion drilling. His case histories show how Atlas milk emulsions have contributed to better wells, drilled faster with substantial savings in over-all costs.

Running Tour

Tenneco Oil Co. has promoted W. H. Medary to southeastern division exploration superintendent. He formerly was Lafayette, La., district exploration superintendent.

Aztec Oil & Gas Co. has transferred L. M. "Steve" Stevens from Farmington, N. M., to Dallas, Tex., as staff petroleum engineer. Ben H. Means succeeds him as Farmington district engineer. Billy Perdue, production foreman, has been transferred from Hobbs, N. M., to Farmington. New personnel includes: Carl E. Jameson, petroleum engineer, Farmington district; and Claude Rohrborough, staff geologist, Dallas.

Wallace B. Johnson is new sales manager of Wright Surveys Inc., Odessa, Tex., firm specializing in secondary recovery well analysis. He formerly was senior operations engineer for The Atlantic Refining Co. in Midland, Tex.

W. B. Johnson

Noel Rietman

Noel Rietman has been promoted to assistant chief production engineer of The Shamrock Oil and Gas Corp. He formerly served as petroleum engineer.

California Research Corp. has promoted Dr. J. W. C. Sherwood to senior research physicist, theoretical and experimental seismology, in the geophysics research section of the La Habra, Calif., laboratory. Among his contributions since joining the staff in 1958 are an analog device for rapid computation of theoretical seismograms and highly specialized methods for filtering of seismic records to improve signal-to-noise ratio and resolution.

In the oil recovery section at California Research's La Habra laboratory, E. L. Dougherty has assumed the post of supervising research engineer and C. E. Johnson Jr. has become supervising research chemist.

W. E. Swearingen

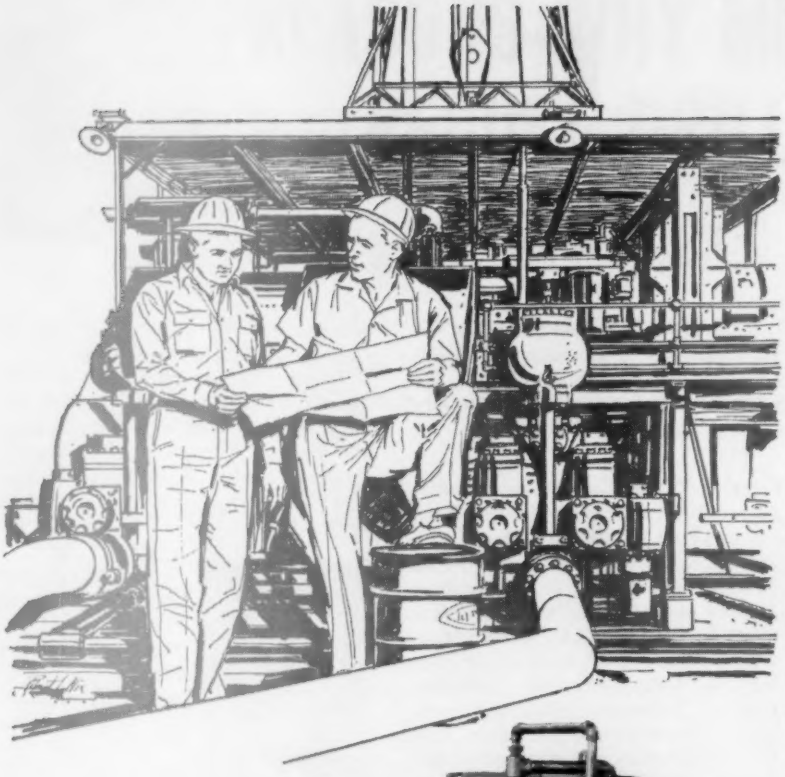
New executive vice president in charge of Livingston Oil Co.'s expanded exploration, waterflooding and land acquisition activities is Wayne E. Swearingen, most recently owner and operator of his own consulting engineering firm. Swearingen also will serve as assistant to Julius Livingston, president of the company.

The California Co. has appointed J. L. LeBlanc acting superintendent of the Delta-Gulf Coast production division during the absence of R. E. France who is on temporary assignment in San Francisco. E. E. Adams is acting assistant division superintendent.

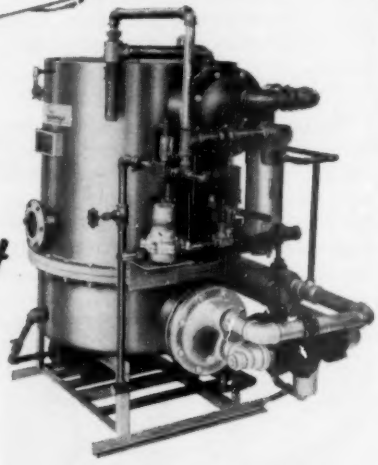
Harold Vance, vice president and manager of Bank of the Southwest's oil and gas department, has been appointed to the API's subcommittee on Smithsonian exhibits, reservoir engineering task force.

Sinclair Oil & Gas Co. has combined its Houston and New Orleans divisions, with the combined operation headquartering in Houston under T. F. Palmer, vice president and manager of the former Houston division.

Continuing as districts in the enlarged operation are Jackson, Miss., and Lafayette, La. R. A. Wright, vice president and former manager of the New Orleans division, has been named manager of the Denver division, succeeding C. W. Horst-



And you can't get far without Fresh Water



That's why more and more producers are making their own fresh water on the spot with the new compact Aquavap evaporator. All you need is a good supply of water, salt or brackish, and an engine to tap for jacket water which acts as the heat source for the evaporator. That's all the heat you need. Inexpensive, simple to install, easy to operate, Aquavap produces water of a purity exceeding U.S. Public Health Service requirements. It is delivered as a packaged unit ready to install. Capacities range from 150 to 12,500 gallons per day of fresh water.

For further details write Dept. P for this new Aquavap Bulletin.

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meier who continues on special assignment. O. G. Simpson, formerly assistant New Orleans division manager, has moved to the same post in Houston.

Other personnel changes resulting from the consolidation are: J. T. Ray who moves from division exploration superintendent to district manager at Jackson, succeeding G. O. Davis who goes to Denver; J. M. Clevenger, formerly division production superintendent, now production superintendent for Sinclair Canada Oil Co.; C. C. Barber, division geologist, now assistant division geologist at Houston; J. C. Knight, division geophysicist, now staff geophysicist at Houston; and B. R. Roark, division production engineer, now in Denver.

C. W. Alcorn

A. L. Solliday

Winners of Texas Mid-Continent Oil & Gas Assn.'s distinguished service award for 1961 are: Charles W. Alcorn, Houston drilling contractor and independent oil producer; and A. L. Solliday, president of Pan American Petroleum Corp.

Dan Turner and Associates Inc., specializing in geological and evaluation consulting in the Rocky Mountains, and Ball Associates Ltd., specializing in geological problems, particularly those needing an engineering, economic approach, have consolidated. Business will continue as Ball Associates Ltd.

E. D. Pressler has been appointed to the newly created post of coordinator of reserves in Humble Oil & Refining Co.'s exploration department headquarters. Prior to this appointment, he served with the southwest region's exploration department.

Stuart K. Clark, well known petroleum geologist, has retired after nearly 38 years' service with Continental Oil Co. He has been manager of the foreign department, as well as assistant to the vice president and general manager of the international exploration and production department. He has served as consultant to the latter department for the past three years.

Better Production Tools Through Research

OTIS Equipment NEWS

Volume III, Number 3 **Otis Engineering Corporation • Dallas** *Production Equipment and Services*

Now...An Otis Flow Line Safety Valve And Pilot For Only $295.00

Proven Otis Safety Valve Design Costs Less Than Many "Substitute" Safety Devices

DALLAS—An all new flow line safety valve employing the time-proven Otis Safety Valve design is now available for installation on wells requiring shut-in protection in the event of flow line breakage. The new valve, designated the Type K Otis Flow Line Safety Valve, may be purchased in the popular 2-inch, 3,000 p.s.i. screw-end size complete with a new Type BE Otis Low Limit Pilot for $295. The Type K Valve is also available with flange-end connections at slightly higher cost. The valve and pilot are designed to automatically shut in a well when flow line pressure drops below the pre-set limit of the pilot. The pressure drop may be due to a break in the flow line itself or the malfunction of auxiliary equipment downstream of the valve. The new Type K Valve and BE Pilot combination offers oil and gas producers effective Otis Safety Valve protection at a new low price — a price which in many cases is lower than that of substitute safety devices such as diaphragm - operated motor valves, etc.

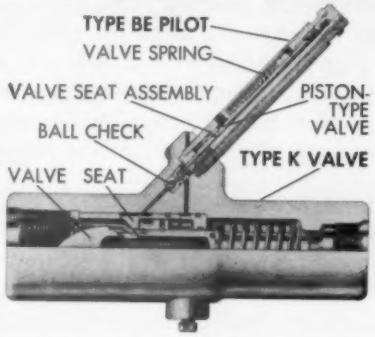
PRICES — TYPE K VALVE AND BE PILOT COMBINATION

Size — Type End	Working Pressure Rating (p.s.i.)	Price
2" — Screw	3,000	$295.00
2" — Screw	5,000	335.00
2" — Flange	3,000	345.00
2" — Flange	5,000	385.00

Note: Be sure to specify pressure range for pilot.

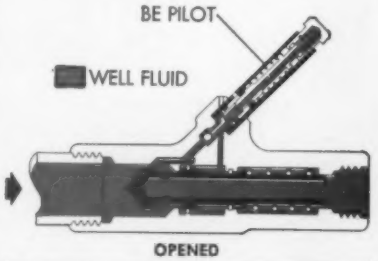
Valve Operating Principles

The Type K Otis Flow Line Safety Valve is a pilot-controlled pressure-operated safety valve designed to automatically shut in a well in the event of abnormal changes in pressure on the flow line or when control pressure from an external source rises above or falls below that for which the pilot is set. On installations where pressure from within the flow line is to serve as the pilot control medium (see schematic drawings), flow line pressure is equalized across the valve and the pilot to permit a spring in the safety valve to hold the valve piston off seat. When pressure within the flow line falls below the set pressure of the pilot, the pilot is designed to exhaust the pressure from behind the valve piston. This action serves to create a differential across the valve and allow flow to close the valve instantaneously. The valve is designed to be reopened by screwing in the nut on the pilot which acts to force the ball check in the pilot boss off seat to equalize pressure across the valve. When installed with the Type BE pilot, the valve serves to provide low-pressure protection. If both high and low pressure protection is desired, the Type E Otis Pilot is recommended. For remote protection, the Type N & P Otis Pilot combination is available.

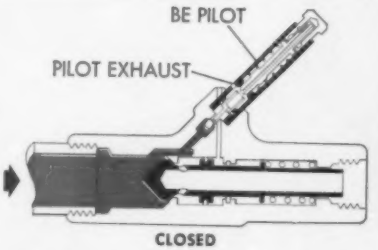


Pilot Operating Principles

The Type BE Low Limit Pilot is a spring-loaded, pressure-actuated control pilot designed to actuate the Type K Otis Flow Line Safety Valve in the event of a drop in flow line pressure below the preset limit of the pilot. The pilot consists of a body, a piston-type valve and valve seat, and a valve spring. When installed on a Type K Valve, a port in the safety valve body, the pilot seat assembly, and the pilot valve serves to admit flow line pressure to the pilot. This pressure acts to hold the pilot valve on seat against the force of the valve spring. In the event of a pressure drop across the valve and pilot, the spring within the pilot is designed to force the pilot valve off seat, permitting the pilot seat assembly to move up so that the ball check in the safety valve boss can seat. This action serves to exhaust pressure within the valve, create a pressure differential across the valve and permit the valve to close.



OPENED



CLOSED

Valve and Pilot Design Advantages

Both the Type K Otis Flow Line Safety Valve and the Type BE Otis Low Limit Pilot are of the simplest design and construction to provide reliable and positive operation. The flow path through the Type K Otis Flow Line Safety Valve has been engineered to permit high flow volumes with a minimum pressure drop. The valve was also designed with no small ports or natural body traps to avoid areas in which hydrates and/or paraffin might accumulate to foul the valve's operation. Both the valve and pilot are so designed as to permit each to be used with other Otis Safety Equipment.

Otis Surface Safety Valves and Pilots have long been recognized as the very finest. Otis Safety Valve Specialists have earned the same enviable reputation. Whatever your well safety valve requirements, Otis can be of help. For more information on Otis Safety Equipment, or for help with a specific safety valve installation problem, call the Otis office nearest you, or write Otis, Dept. 3-E, P.O. Box 35206, Dallas 35, Texas. You'll find experienced Otis Safety Valve Specialists ready to help you — anxious to serve you . . . with the widest variety of field-proven safety valves and pilots available today.

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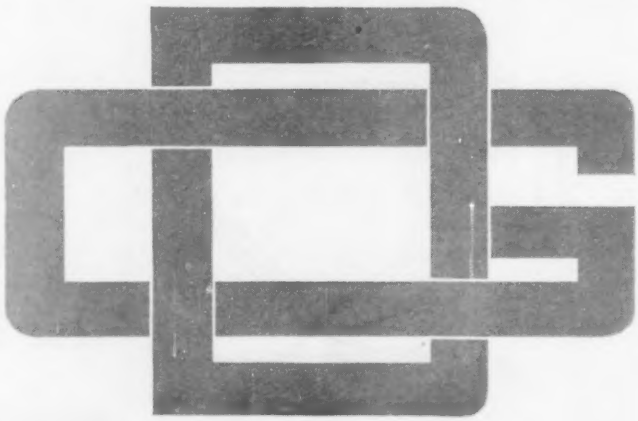
OTIS
Engineering OTIS Corporation
General Offices:
6612 Denton Drive • Dallas

GARDNER-DENVER 700 DRAWWORKS

Only Gardner-Denver, with its 100 years' experience in building every type of equipment for the oil field and industry, could have produced the completely new GD-700 drawworks. An eight speed, seven hundred horsepower unit, it is unparalleled in its depth class. The GD-700 design features short shafts that reduce bearing center distances . . . unit engineering of sprockets and chains to reduce wear . . . heavily reinforced side plates for rigid bearing support. Every component has been selected and engineered to produce a balanced drawworks that will operate with speed and low cost maintenance on drilling programs in the 5,000 to 10,000 foot range. □ The drawworks, transmission, controls, compound, engines and pump drives are mounted on a single main skid. When moving, only the auxiliary brake with its skid and the engines need be removed. Throughout the engineering of the GD-700, every drilling problem has been considered to assure the operator of a drawworks that is fast, safe and easy to move. □

The new Gardner-Denver 700 drawworks features: 330° wrap drum brakes □ Eight hoisting speeds and reverse □ Four rotary speeds and reverse □ Air controls for all rig operations □ All friction clutches mounted outboard □ Auxiliary positive Lo drum clutch □ Positive transmission clutches □ Centralized brake lube-center □ Hydromatic brake water level control at console □ Two package moving **GARDNER-DENVER**



© 1961 Gardner-Denver Company, Quincy, Illinois

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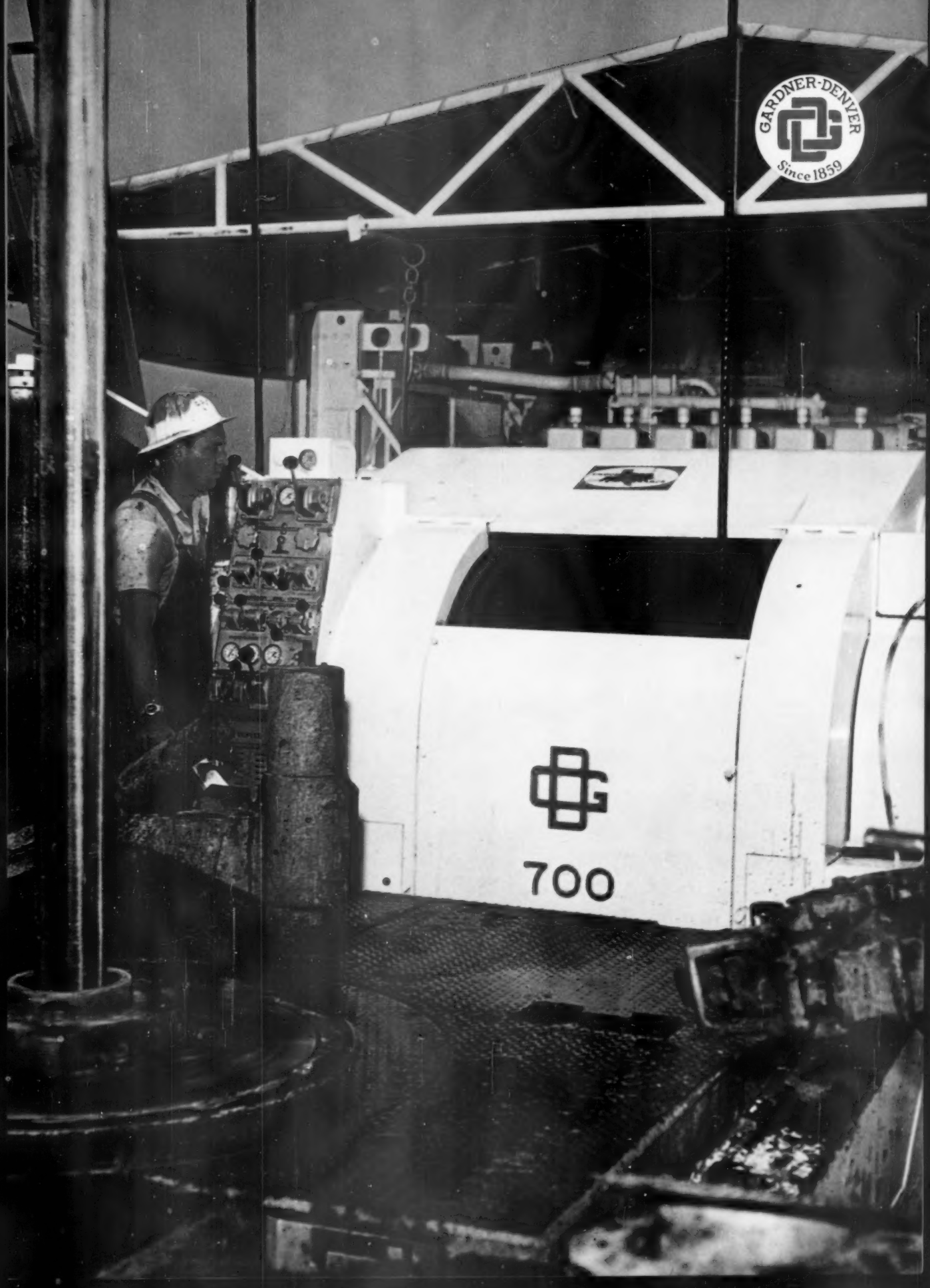
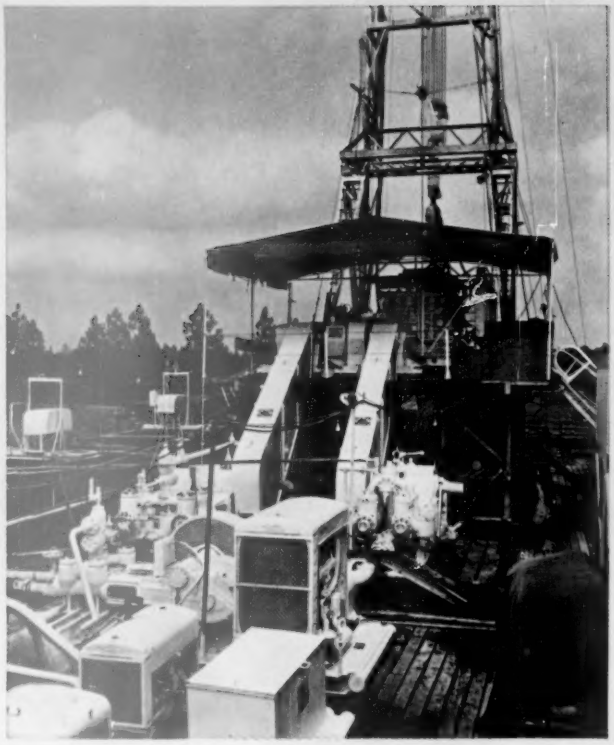

GARDNER-DENVER
Since 1859
700



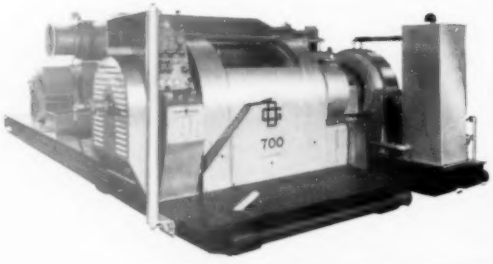
Trim-True
TRAVELING BLOCK 200 TON

Turbo-Lubricated
SWIVEL 200 TON

Turbo-Lubricated
ROTARY 17 1/2"

The GD-700 is a single skidded drawworks with all components mounted in line on the main skid section except the hydromatic brake and the engines. On location only these two elements need be rigged up to be ready for spudding-in.

The drum clutches and chains are mounted outboard where they may be easily serviced and inspected. Drum and brakes can be checked or inspected by removing the full width front panel. A unique tilting arrangement allows the driller's console to drop forward exposing valves and piping.



Full line manufacturing from rotary table to mud pumps . . . Gardner-Denver drilling equipment has been designed as a matched team for greatest drilling efficiency. In addition to the drawworks, there is a swivel, block, rotary table, compressor and mud pump to match every drilling program.

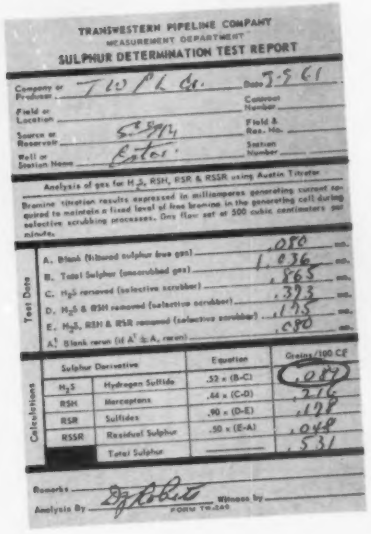
GARDNER-DENVER Since 1859 — 1 CENTURY

Gardner-Denver equipment combines imaginative engineering and modern technology with a century of experience.

GARDNER-DENVER

U. S. A. Gardner-Denver Company, Quincy, Illinois. Offices in principal U. S., Canadian and Mexican cities. Petroleum Products: Dallas, Texas. **CANADA** Gardner-Denver Company (Canada), Ltd., 14 Curity Avenue, Toronto 16, Ontario. **INTERNATIONAL** Gardner-Denver International Division, 233 Broadway, New York 7, N. Y. Offices: Buenos Aires, Argentina; Artarmon, N. S. W., Australia; Brussels, Belgium; Rio de Janeiro, Brazil; Santiago, Chile; Barranquilla, Columbia; Lima, Peru; Ndola, N. Rhodesia; Salisbury, S. Rhodesia; Johannesburg, Transvaal.

Maloney-Crawford Solves Another Sour Gas Problem



TRANSWESTERN PIPELINE COMPANY
MEASUREMENT DEPARTMENT
SULPHUR DETERMINATION TEST REPORT

Company or Producer: T W P L Co. Date: 3-5-61
Field or Location: Eater. Contract Number:
Source or Reservoir: Strip Field & Res. No.:
Well or Station Name: Eater. Station Number:

Analysis of gas for H_2S, RSH, RSR & RSSR using Austin Titrator
Bromine titration results expressed in milliamperes generating current required to maintain a fixed level of free bromine in the generating cell during selective scrubbing processes. Gas flow set at 500 cubic centimeters per minute.

Test Data

A. Blank (filtered sulphur free gas)	.050 ma.
B. Total Sulphur (unscrubbed gas)	1.036 ma.
C. H_2S removed (selective scrubber)	.865 ma.
D. H_2S & RSH removed (selective scrubber)	.393 ma.
E. H_2S, RSH & RSR removed (selective scrubber)	.195 ma.
A' Blank rerun (if A' ≠ A, rerun)	.080 ma.

Calculations

Sulphur Derivative		Equation	Grains/100 CF
H_2S	Hydrogen Sulfide	.52 x (B-C)	.089
RSH	Mercaptans	.64 x (C-D)	.316
RSR	Sulfides	.90 x (D-E)	.178
RSSR	Residual Sulphur	.50 x (E-A)	.058
	Total Sulphur		.531

Remarks:
Analysis By: D. J. Roberts Witness by:
FORM TW-260

TRANSWESTERN PIPELINE CO.'S PROBLEM: 100 grains H_2S/100 CF in an 18MM-SCF/D stream.

THE REQUIREMENT: Reduce H_2S to .25 grains/100 CF.

MALONEY - CRAWFORD SOLUTION: An automated Sweet-A-Mine gas treating plant with ratio-rate control system.

THE RESULTS: The Sweet-A-Mine reduced the H_2S content to .089 grains/100 CF. The actual field report on the Sweet-A-Mine's performance is reproduced above.

CONCLUSION: If you have a sour gas problem, call on M-C. You'll get a sound solution.

Maloney-Crawford
Designers and Manufacturers of
Processing and Production Equipment
Box 659 Tulsa

It's cast of AMPCO® metal
...even salt water can't damage it

Tough pumping conditions are duck-soup to AMPCO metal. It's a two-fisted copper-base alloy that is specially engineered to guard against failure caused by corrosion, erosion, abrasion, and cavitation-pitting. It provides exceptional strength—yet it weighs 10-15% less than ordinary bronzes.

Check for this protection when you look at specifications of duplex and triplex pumps. And — insist on fluid ends of AMPCO metal for replacements on your old pumps.

Send coupon today for further information on AMPCO metal in corrosive applications.

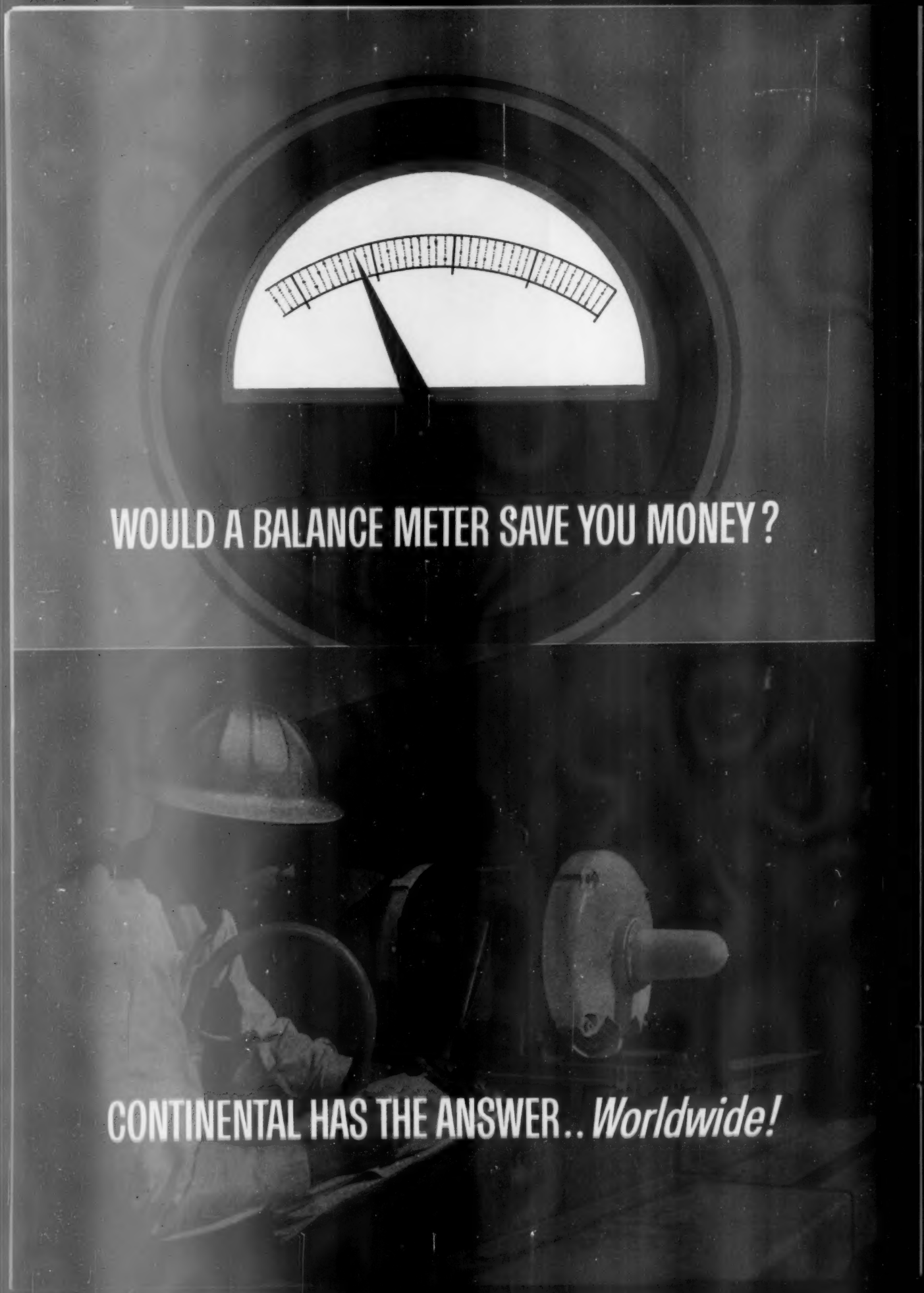
AMPCO® AMPCO METAL, INC., MILWAUKEE 1, WIS.

West Coast Div.: Huntington Park, Calif. • Southwest Div.: Garland (Dallas County), Texas

AMPCO METAL, INC.
Dept. 381K
Milwaukee 1, Wis.

Send me Bulletin on AMPCO® metal

NAME.....
TITLE.....
COMPANY.....
ADDRESS.....
CITY..... ZONE..... STATE.....
PI-2C


WOULD A BALANCE METER SAVE YOU MONEY?
CONTINENTAL HAS THE ANSWER.. *Worldwide!*

This exclusive, built-in balance meter on Green Triangle Electric Pumping Motors lets you check your well's condition at a glance. Needle steady; no trouble. Needle jerking; trouble . . a broken rod string . . an unseated pump . . paraffin deposits . . etc. Meter can be used to balance your wells for lower power costs too. Ask to see one at work!

CONTINENTAL

EMSCO

CONTINENTAL-EMSCO COMPANY
a Division of
The Youngstown Sheet and Tube Company
General Offices: Dallas, Texas
Export Office: New York, New York

EM11-31

D & P Equipment

Plastic Pipe For Producers

Designed for corrosive applications at high pressures is a new plastic pipe. It is recommended for use in crude gathering and salt water disposal lines and in waterflood operations. As downhole tubing, it may be used in salt water disposal wells and combination injection and disposal wells. It is now available in 2-in. for 500 psi service and is expected to be available in 2, 3 and 4-in. sizes within the year. Structure consists of a glass fiber reinforced core co-cured with and protected by a specially formulated liner and cover. The high strength glass fibers are chemically linked with a plastic matrix based on Enjay Chemical Co.'s Buton A-500 resin. *Spiral-Glas Pipe Co.*

Circle number (1) on reply card

Hinged Clapper Check Valve

Checkaroo is a new and functional rubber seal check valve with clapper hinge pin that pivots the clapper out of stream for full pressure and unobstructed passage. It has full pipe opening, resulting in 40% less pressure drop across the valve. The 20-deg clapper hinge pin assures easy action and is said to cut dead weight by 90%. Available in 2, 2½, 3, 4 and 6 in., it is non-lubricated; can be threaded, flanged or victaulic grooved at both ends; and operates in vertical or horizontal position. Double O-ring gaskets eliminate pressure on threads and protect them from outside corrosion. The Checkaroo, equipped with pressure gage or test vent, is now available in semi-steel and soon will be available in ductile iron and steel. *Frank Wheatley Pump & Valve Mfr.*

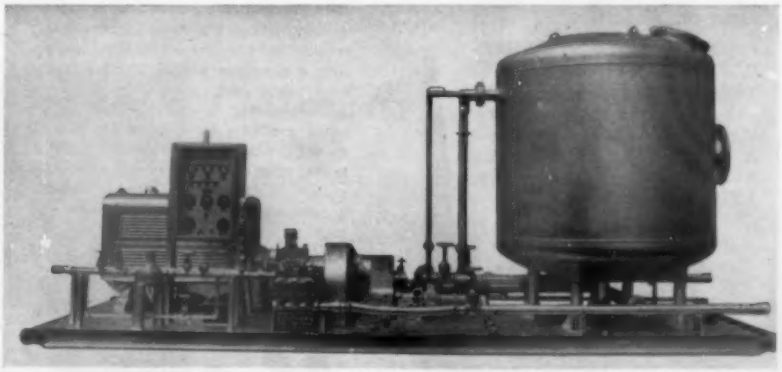
Circle number (2) on reply card

Chemical-Electric Treater

Field-testing of a new chemical-electric crude-oil emulsion treater has been announced. The Chemelectric Treater features simple installation, automatic operation at minimum treating temperature, vapor-tight pressure vessel with built-in low pressure de-gassing section and low utility cost (normally less than 1 kw per hr). It is said to save fuel through reduced heat demand, conserve light ends and maintain true API gravity, make more crude available through elimination of vapor losses and substantially reduce scale and corrosion problems because of zero or minimum heat requirements. *Petrolite Corp., Petreco Div.*

Circle number (3) on reply card

Packaged Waterflood Unit



To filter and chemically treat raw, oilfield salt water and inject it into formation is a packaged waterflood unit. It is automatic in normal operation and can be used where electricity is not available. Components include: Minneapolis-Moline power unit (other makes are available as the prime mover); two Goulds all-bronze centrifugal pumps for feed water and filter backwash service; Frank Wheatley triplex plunger

pump for injection; Texsteam chemical injector; and Murphy central control panel. Feed pump and well injection pump will perform unattended and independently of each other. Backwash pump is manually operated and actuated by on-off switch located in the panel board. Chemical injection pump operates on 50 psig of natural gas, is automatic. *Southern Engine and Pump Co.*

Circle number (4) on reply card

Light 1500-W Electric Plant

A 1500-w electric plant that weighs only 99½ lb has been introduced. Kohler, by redesigning the generator and using aluminum for the engine's fly-wheel and many other parts, has made the new model 1.5M25 almost 25% lighter than its predecessor. Officials shown weighing in the new unit are: F. W. Nelson, Kohler Co. sales and service administrator; R. A. Saletta of the firm's San Francisco branch; and O. R. Moore Jr. of the Richmond branch. *Kohler Co.*

Circle number (5) on reply card

MARTIN RUBBER & DUCK RINGS give excellent life in dirty abrasive fluids . . . high or low gravity . . . much or little water . . . shallow or deep wells. They last for years in the easier pumping wells. Replacement rings cost comparatively little.

MARTIN PLUNGER BODIES, precision grooved, drilled and threaded (no underneath fluid passage), usually last for years. Tube or barrel costs are often cut in half.

The replaceable SYNTHETIC RUBBER GUIDES in MARTIN CAGES last longer than any metal, and the cushioning of the ball increases your ball & seat life. Results are often truly amazing. (Patent No. 2,591,174)

Write for our new catalog or see it in the Composite (24th Edition). All products sold thru supply companies.

JOHN N. MARTIN
Manufacturer
9 W. BRADY STREET • TULSA, OKLAHOMA

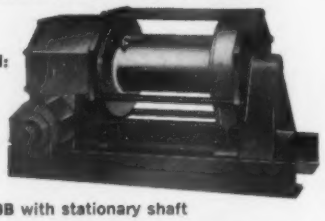
Koenig INTRODUCES A REVOLUTIONARY NEW TYPE OF HEAVY-DUTY POWER WINCH

FEATURING TORQUE TRANSMISSION DIRECT FROM GEAR SPIDER TO DRUM . . . NO KEYS TO SHEAR

20,000 pounds safe hoisting capacity

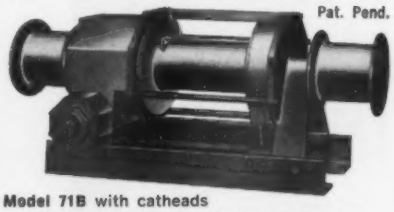
Outstanding features of the NEW KOENIG WINCH:

★ Drum torque load is NOT transmitted by drum shaft . . . no keys to shear . . . torque is transmitted direct from gear spider to drum by means of multiple-splined collar in gear housing.
★ Entire unit, including safety brake, is lubricated by the oil-bath principle, with a generous supply of oil to prevent overheating.
★ Engineered to use standard lubricants available throughout the world.
★ Multiple-plate automatic safety brake, running in oil with one-direction clutch, is easily adjusted or released.
★ Accurate drum clutch position indicator.
★ Gear ratio — 38:1.
★ Nickel-bronze alloy worm gear. Hardened and ground worm mounted on Timken roller bearings.



Model 70B with stationary shaft

Pat. Pend.



Model 71B with catheads

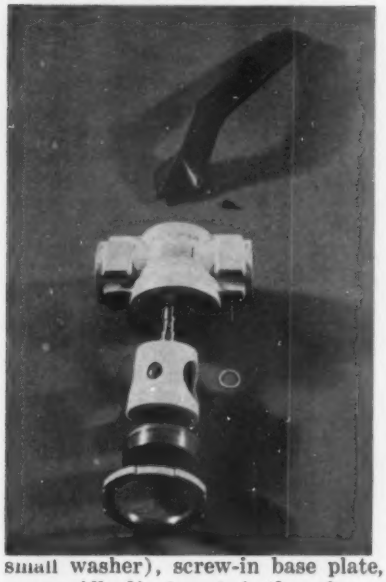
THIS ADVANCED-DESIGN KOENIG WINCH IS RECOMMENDED FOR OIL-FIELD EQUIPMENT, PUBLIC UTILITIES, HEAVY WRECKERS, CONSTRUCTION, AND OTHER HEAVY-DUTY JOBS.

Koenig winches have served the industry with dependable pull and hoisting power since 1934. Koenig also builds a complete line of utility and service bodies.

IRON WORKS, Inc.

P. O. BOX 7726, DEPT. W • HOUSTON 7, TEXAS

"New Concept" Ball Valve

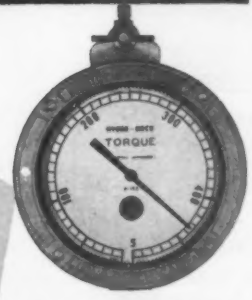


Said to be the most easily adjusted, maintained and overhauled valve available is the Con - O - Sphere, the major design feature of which is a "sealing capsule" of conical-shaped Teflon molded around the ball that controls on-off-action. Con-O-Sphere has only seven parts — sealing capsule with integral handle stem, valve body, handle, Teflon stem seal (a small washer), screw-in base plate, lock nut and set screw. All adjustments in the valve are made by tightening the base plate. Simple replacement of the capsule and a new stem seal completely rebuilds the valve. This can be done in the line in approximately 3 min. The valve requires no lubrication. It is being manufactured in sizes ranging from ⅛ to 2 in., in a working pressure range from vacuum to 1440 psi and in a number of metals. *W-K-M Div., ACF Industries, Inc.*

Circle number (6) on reply card

ROTARY TORQUE

for DOWN HOLE VISION



A good Weight Indicator is not enough. For complete knowledge of down hole conditions install the Martin-Decker Hydro-Mech Torque Assembly. This unit fits under the rotary or secondary chain and provides sensitive indications of:

Hole and Bit Conditions
Fishing Operations
Diamond Coring
Air and Gas Drilling

MARTIN DECKER

WRITE FOR DESCRIPTIVE LITERATURE
MARTIN-DECKER CORPORATION, DEPT. P-60
3431 CHERRY AVENUE, LONG BEACH 7, CALIF.

World's principal manufacturer of Oil Well Drilling Instruments

REDA Does the Job Better . . . and at LOWER COST!

For this flood project a Reda Submergible Electric Pump is in operation. It is one of the thousands of installations for which Reda Submergible Pumping Units were selected.

Here's Why:

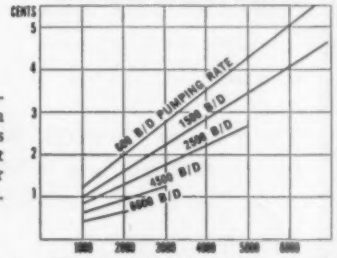
PROVEN PERFORMANCE

Over 80 million barrels of oil have been recovered profitably from wells which would have been abandoned as unprofitable producers.

PROVEN ECONOMY

Average cost of producing with Reda Submergible Pumps is less than one cent per barrel of fluid for each 1,000 foot lift.

LIFTING COST Per Barrel of Fluid



*Included: Electric Energy (10 Mills Per KWH), Run and Pull, Repairs, Upkeep, Transportation, Labor and Amortization (5 Yrs.)

A COMPLETE LINE

Reda Submergible Pumps are designed to meet every pumping need — for wells with small fluid volumes, large fluid volumes, new wells or secondary recovery operations. Daily production rates from 20 barrels of oil to 18,000 barrels of salt water producing less than 1% of oil. Depths of wells are from 450 feet to 13,000 feet. Complete line from ½ H.P. to over 300 H.P.

Write for Bulletin R-686 Today

SIGN OF QUALITY SUBMERGIBLE REDA PUMPS

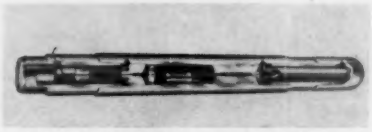
REDA PUMP COMPANY
BARTLESVILLE, OKLAHOMA

Manufacturer of Submergible, Electric Motors and Pumps for over 40 years. Pumps for Oil, Brine, Water, Gasoline, Jet Fuel, Chemicals, LPG

For Further Information on Advertised Products See Reader Service Card

Bottomhole Pressure Gage

A gage for measuring pressures from pumping, flowing or shut-in wells is in production. It is the Pressure Sentry MK 7 that is permanently installed below the pump, with a portable surface unit that provides a permanent record of reservoir pressure on chart paper. It may be used in 4½-in. and larger casing, in wells with temperatures to 275 F and is available in pressure ranges to 8000 psi. Bourdon tube-coded disk assembly sends digital signals up a single conductor wire to the surface recording unit. Readout is not influenced by absolute value of the current or resistance of the wire. Pressure readings can be taken at any time without downtime by simply attaching recorder to wellhead connection and turning on recorder. Complete, continuous reservoir records can be maintained on secondary recovery operations. A timer unit is available to automatically record pressures at predetermined intervals. *Ball Brothers Research Corp.*



Circle number (7) on reply card

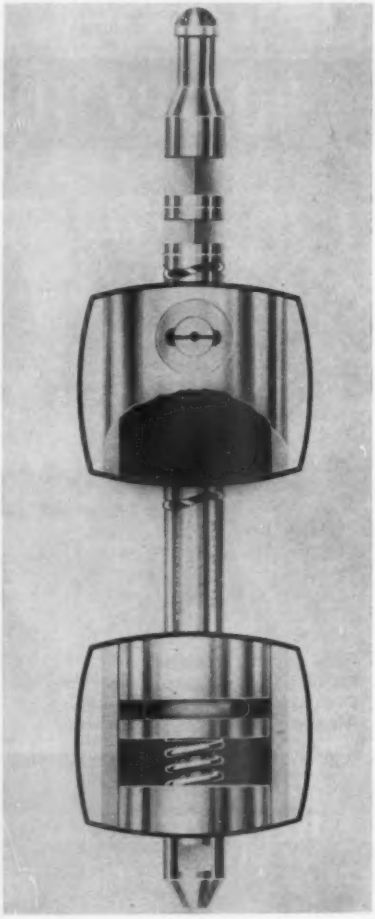
Arc-Free Static Starter

A static starter for motors, eliminating a switch arc in corrosive or explosive atmospheres, has been developed. It utilizes the Trinistor, the Westinghouse-developed silicon-controlled rectifier that blocks conduction in the reverse direction but provides complete control of conduction in the forward direction. Proper arrangement of Trinistor units permits total control of a 3-phase inductive or resistive load. The low-energy level signal required to control a Trinistor unit makes it possible to monitor a load directly from a computer without preamplification. The static starter is modular and has no moving parts. It enables remote operation. Standardized starter designs are applicable to 20-hp motors "across the line" and up to 75-hp motors with reduced voltage. *Westinghouse Electric Corp.*

Circle number (8) on reply card

Subsurface Sampler

Oil, gas and water samples can be



NEW

FROM MERLA

WFM-12R

GAS LIFT VALVE

WITH ½" MAIN PORT

For KB and KC Mandrels!

Merla's WFM-12R is the first and only pilot-operated gas lift valve with ½" main port for the KB and KC series mandrels!

The wire-line retrievable WFM-12R has passed the toughest test of all: Right now in Mississippi this great new valve is simultaneously producing heavy salt water from a 12,000 foot dual installation.

For more information about the WFM-12R, write for bulletin 961.

TOOL MERLA CORP.

Contact your nearest Merla representative or

MERLA TOOL CORPORATION • P. O. BOX 2576

DALLAS 21, TEXAS

New Drilling Detergent Saves Drilling Dollars

D-D®, Magcobar's new drilling detergent, is recommended only for operators and contractors who like money. Because, when you use D-D on your well, it's hard **not** to save money.

Look what D-D does. By reducing surface tension in water base muds, it speeds up the rate of penetration. What's more, it settles out sand, extends the use of low pH muds to greater depths, and reduces costs of chemical treatment.

Another **Well Done** with Magcobar Technology

®Registered trademark, Magnet Cove Barium Corporation.

The really big surprise about D-D is that so little does so much. Initial treatment is only ten gallons per 500 barrels of drilling fluid. Maintenance is two to six gallons per tour.

Like money? You can learn all about D-D by writing for the new brochure. Magnet Cove Barium Corp., P. O. Box 6504, Houston, Texas.

Magcobar
Complete
DRILLING MUD SERVICES

DRESSER INDUSTRIES, INC.
OIL • GAS
CHEMICAL
ELECTRONIC
INDUSTRIAL

obtained with this new subsurface sampler. It is 1¼ in. in diam and 47 in. long (66 in., large size). Samples are obtained at desired location by presetting tripping clock. The instrument can be purged and sealed before sampling, and the sample can be removed under pressure if desired. Capacities are 250 cc and 500 cc. *The Kuster Co.*

Circle number (9) on reply card

Field Kit To Join Delrin Pipe

A kit needed to heat-join Delrin acetal resin pipe is now available for oil field use. The 23-lb kit, easily

carried on location, includes a 1500-w a-c portable generator, special heat-joining tool, cold ring, chamfering tool and pipe cutter. Procedure is to melt a layer of the pipe's outer surface and a layer of the inner surface of a factory-installed, sleeve-type coupling. Coupling and pipe are then joined under hand pressure for several seconds until the molten resin solidifies. Under normal field conditions, a joint may be made in 25 sec at rates up to 800 ft of installed pipe per hr. Coupling and pipe are heated for 15 sec and then joined. The pipe end solidifies within the coupling during the final 10 sec. The joining process is operable in rain or snow and at temperatures below zero. *E. I. du Pont de Nemours & Co.*

Circle number (10) on reply card

AXELSON-GARRETT

SAFOMATIC VALVES

COMPLETE AUTOMATIC PROTECTION AGAINST OVER-PRESSURE DAMAGE—LINE BREAKAGE LOSSES!

Here is a simple, foolproof safety valve that will automatically shut off any gas or fluid line when pressures rise or fall beyond predetermined limits. Easy to install Safomatic Valves are made in an operating range from 15 to 10,000 p.s.i. and in three control head types — direct operated, actuated by the pressure of the line on which installed — remote operated, actuated by pressure source remote from the installation — pilot operated, actuated by one or more safety devices which monitor system functions.

Readily adjusted or reset, both high and low pressure settings on Safomatic Valves may be changed in a matter of minutes while the valve is in service and under pressure. Just as easily, the balanced stem design permits manual resetting.

With Safomatic Valves you can design an economical, positive safety system for every type application where high and low pressure limits are important. Write today for Brochure #SFO.

USI Axelson-Garrett

DIVISION OF U.S. INDUSTRIES, INC.

"Products Designed to Give Oil a Lift" General Offices: Longview, Texas

Oil Valve For Fluid Control

The 4600 series Dump Valve is a mechanical oil valve for use in fluid control on oil and gas separators, horizontal emulsion treaters and water knockouts. It is operated by a float located in the separator or other vessel and mechanically linked to lever actuator on the valve. Diaphragm balances seat area, equalizing vessel fluid pressure and downstream pressure. By removing cap screws, entire inner valve mechanism can be removed for reworking, reversing and/or replacing valve disc. This valve is available in 2-in. size with screwed ends and in 3 and 4-in. sizes with flanged ends. *Enardo Manufacturing Co.*

Circle number (11) on reply card

Fall Brings New Engine Line

Plans to introduce an entirely new concept in industrial engines and engine-driven generators have been disclosed. The new "J" line of 12 basic engines provides such unusual features as interchangeable parts, choice of gas, gasoline or diesel fueling and water-cooled or air-cooled models — all fabricated from one basic set of tooling. First units in the series include 1, 2 and 4-cylinder models ranging from 3 to 15 kw. The 12 basic engines can be produced in an almost limitless variety of models with minor modifications and selection of accessories. Another major feature is accessibility of all parts for servicing on one side of an engine, thus reducing downtime and lowering costs of maintenance and repairs. *Onan, division of Studebaker-Packard Corp.*

Circle number (12) on reply card

Ductile Iron Strainers

Ductile iron line strainers suitable for 600 psi at 650 F or 1000 psi at 100 F are available in ¼ through 3-in. sizes with screwed ends. For steam, water, air, oil, gas or chemi-

Photograph courtesy of Standard Oil Company (N. J.)

Why Nickel Steel Pipe Keeps Fishing Tools on the Shelf

The deeper you drill, the greater the possibility of drill-pipe failure. Torsion, tension and fatigue—they all increase with each additional foot of hole.

But AISI 4340 nickel steel has the muscle to keep your drill pipe on the job when other materials quit.

Yield strengths as high as 105,000 psi and tensile strengths as high as 150,000 psi are provided by AISI 4340. When drill strings are long and heavy, this added strength prevents many a drilling crew from "going fishing."

A bar of AISI 4340 (1⅛" diameter) resists 130,000 psi in torsional stress when it's oil quenched and tempered at 1200° F. And this helps to prevent failure in a 100-200-ton string of drill pipe.

With each added length of drill pipe, bending stresses tend to increase. But AISI 4340 nickel steel, hardened and tempered, provides a fatigue strength of 75,000 psi at 4 million cycles—enough to keep your string going down without downtime.

For deep-hole drilling—12,000 feet and more—AISI 4340 provides an outstanding combination of ductility, toughness, and strength. In the heat-treated condition, it's shock- and impact-resistant, wear- and abrasion-resistant.

With such excellent properties, it's no wonder that AISI 4340 is such good insurance against drill-pipe failure in deep holes.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street INCO New York 5, N. Y.

INCO NICKEL

NICKEL MAKES STEEL PERFORM BETTER LONGER

For Further Information on Advertised Products See Reader Service Card

W7J W7R-2J

We don't change the name...we change

Year-after-year the names of Hughes bits remain the same . . . but not their performance. This is being improved, constantly. Regardless of how well a bit performs, our engineers are never satisfied. They are continually challenged by new facts from the field and from research to find new ways to increase penetration rate . . . or footage . . . or both.

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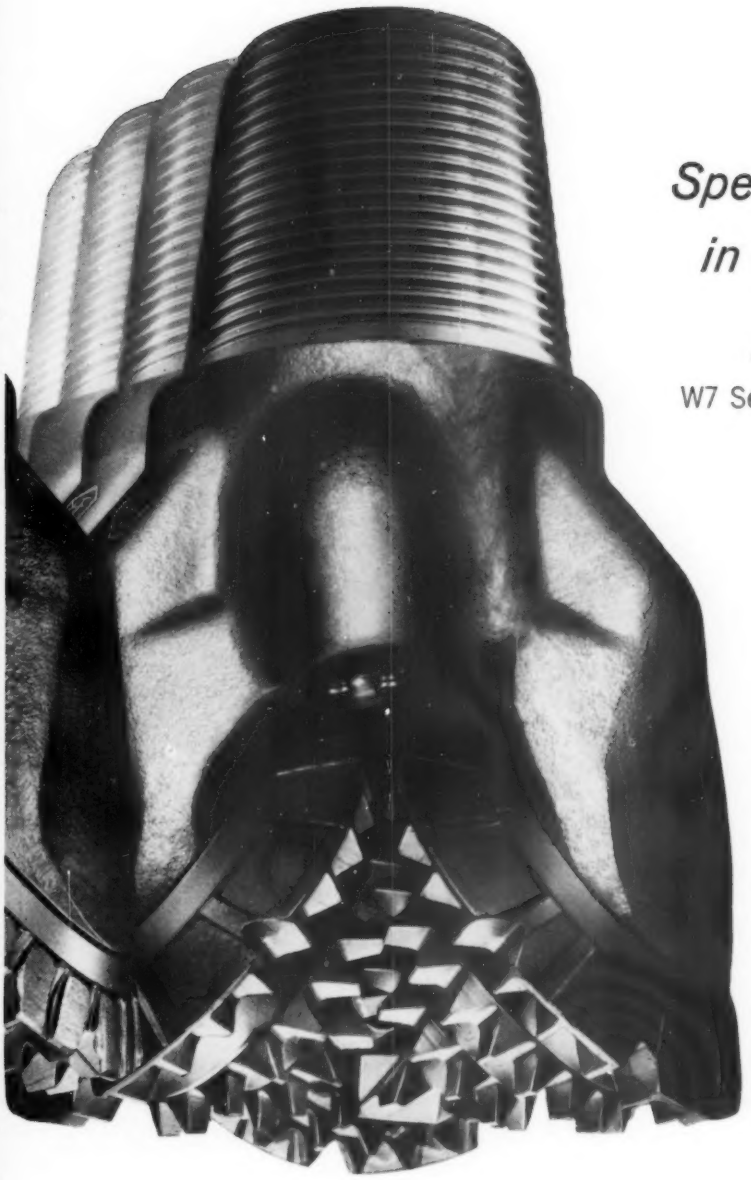


W7R-J

the performance

Today's Hughes bits come to you under the same series names they have for years... but there's a whale of a difference between the performance of the old and new bits. That's why you get the most hole per bit today with Hughes bits. And why you'll get more tomorrow. To keep your hole costs down — go all the way with HUGHES.

Specific new improvements in the **Hughes W7 Series**

4 recent changes have lengthened life of W7 Series bits, made it possible to use heavier weights, and increased penetration rate

Change No. 1 has materially increased bearing life through the improvement of metallurgy of rollers and roller bearing surfaces.

Change No. 2 has increased resistance of heel row teeth to gage wear through use of webs connecting heel row teeth.

Where gage wear **is not** a serious factor, the "L" shaped gage on the W7 helps these bits deliver more footage and faster penetration rate. For areas where highly abrasive formations are encountered, two or more teeth are joined by webs to provide increased gage facing and greater resistance to gage wear. In the W7R-2, webs join the heel teeth in pairs. The W7R has three or more teeth joined by webs.

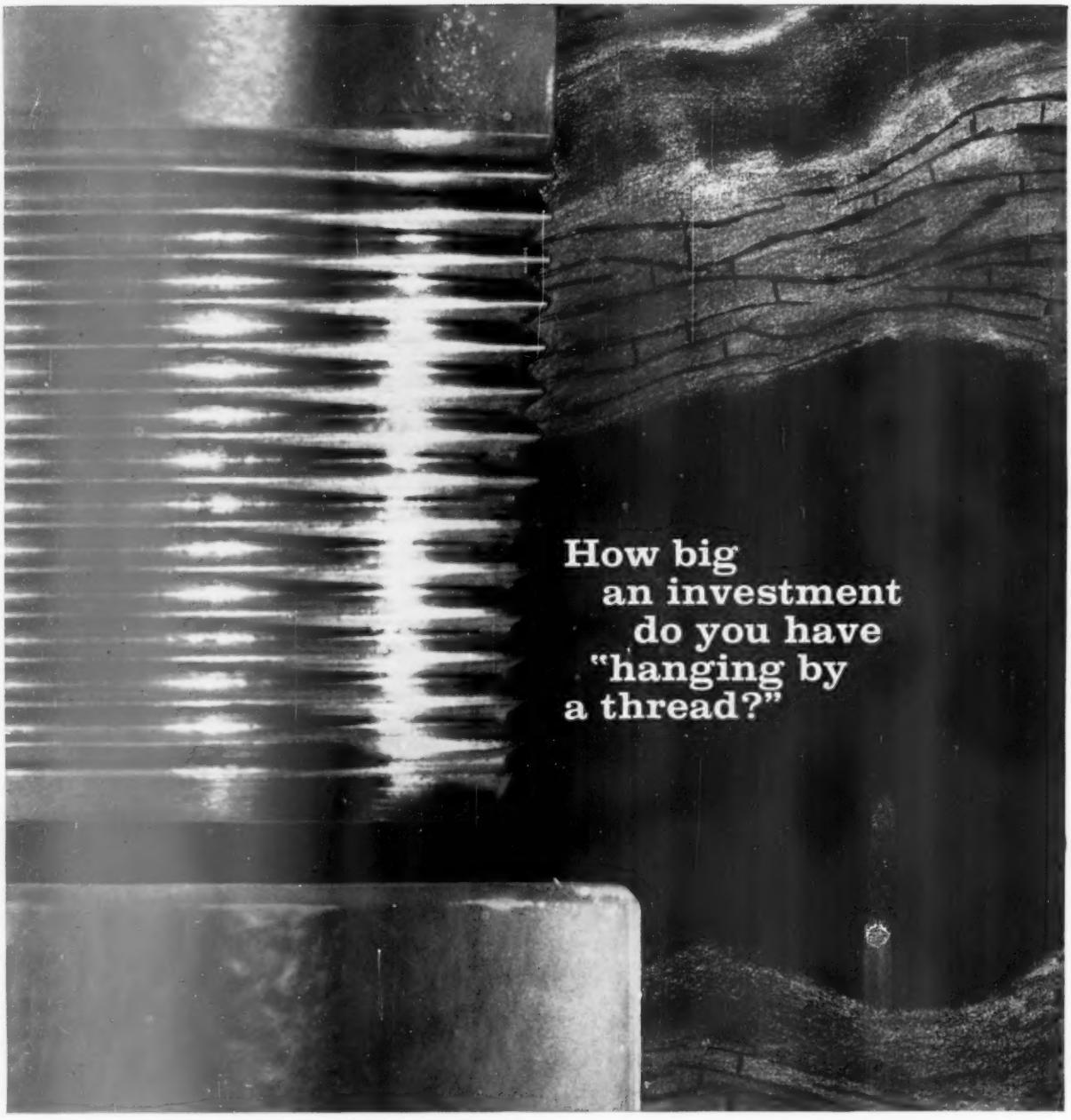
Change No. 3 has permitted use of increased weight on bit, and equalized wear on all three cones. This has been accomplished by redesigning the cutting structure and cone shell.

Change No. 4 has extended cutting life of bit in areas where nose bearing wear is serious. This has been done through the use of improved integral pilot pin bearing.

In hard and hard abrasive formations, drillable with milled-cutter bits, operators prefer Hughes W7 series bits for their low cost performance.

HUGHES

ORIGINATOR AND WORLD'S LEADING DEVELOPER OF CONE-TYPE ROCK BITS



The deeper you go for oil the bigger your investment . . . and the deeper you go the more dependent that investment becomes on the threads that link your casing or tubing into an inseparable unit. That's why the threads for CF&I Seamless Casing and Tubing must pass the most exhaustive of tests—including painstaking checking with a contour microscope. The right lead . . . the right taper . . . the right height . . . the right size—these are some of CF&I's requirements that mean extra strength and pressure-tightness.

Available in sizes 2⅜" through 9⅝" O.D., CF&I Casing and Tubing meets API STD 5A specifications. Your nearby CF&I sales office or distributor has complete details and can provide prompt delivery. B494

Steel . . . means strength and economy

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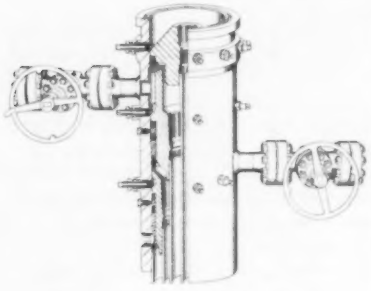
Denver • Oakland • New York
Sales Offices in Key Cities

cals, the #801J series features an accurately machined body recess and screen cap so that the screen fits snugly without binding. Steam or liquid is forced through the screen and cannot by-pass. A straight thread on the screen cap with a machined face and copper clad asbestos spark plug type gasket permits easy screen removal. *OPW-Jordan Corp.*

Circle number (13) on reply card

Time-Saving, Compact Head

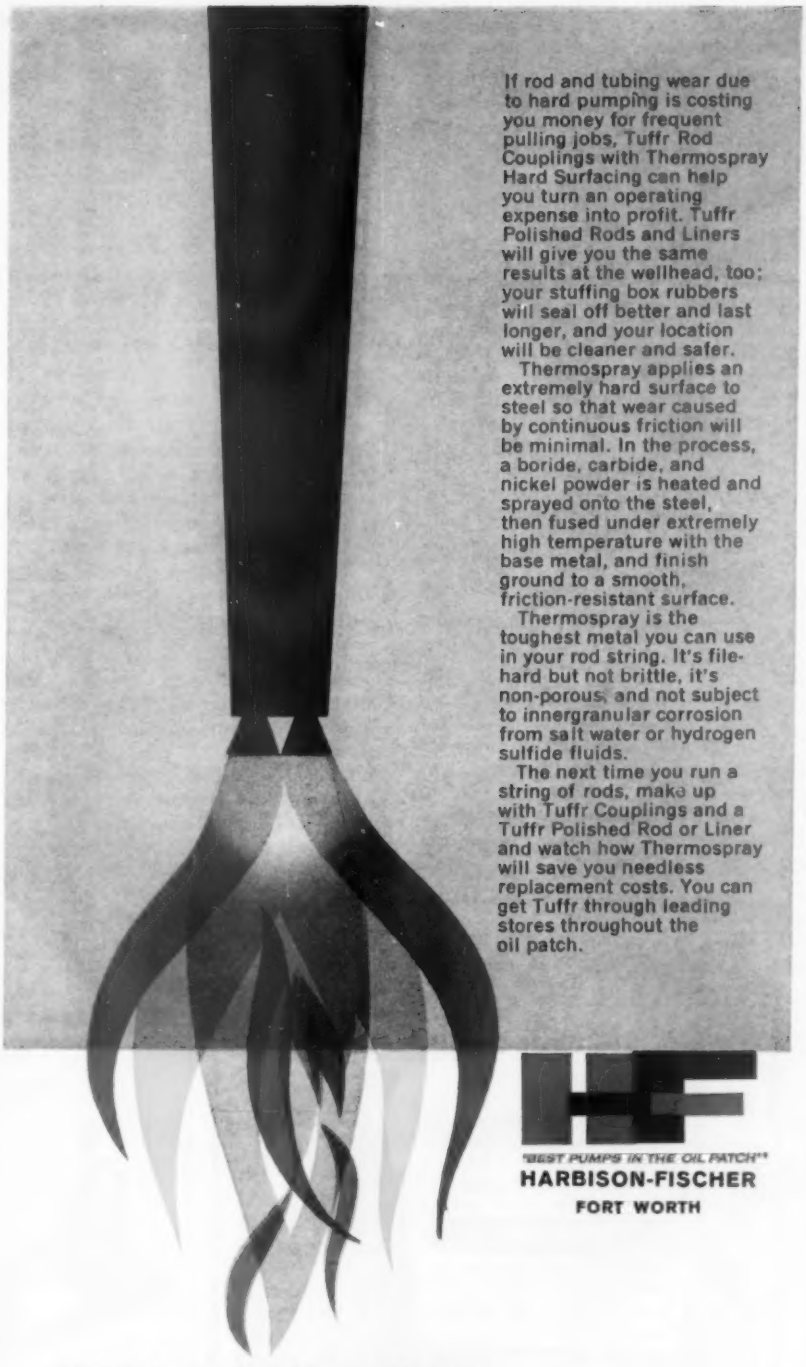


Promising to save as much as 48 hr in drilling and completing a deep well is this Compact Head. It is used in place of two or more casingheads and the tubinghead of a conventional hook-up. For instance, where 13⅜, 9⅝ and 5½-in. casing and 2-in. tubing are planned, the head is attached to the 13⅜-in. casing, and the 12-in. blowout preventer is flanged to it. The 9⅝ and 5½-in. casing and 2-in. tubing are successively landed and packed off. Side outlets from the head connect with each casing string. The 12-in. preventer is not removed until the operator is ready to flange the Christmas tree to the head. The Compact Head eliminates several flanged joints that are possible sources of leaks and several sets of studs and ring gaskets that are corrosion hazards. *Cameron Iron Works Inc.*

Circle number (14) on reply card

Small Swivel

The smallest-capacity swivel in National's line is the new T-12, which has an API rating of 25 tons at 100 rpm and a comparative dead load rating of 50 tons. It is designed for use with small portable or trailer-mounted rigs in exploratory, slimhole and shallow drilling operations or workover jobs. It is 46 in. high, 18¾ in. wide, and weighs approximately 525 lb. Recommended drilling depths are 1000 to 2000 ft. It features high strength-to-weight ratio, low center of gravity, precision line bored bail, final run-in testing and opposed Timken tapered


If rod and tubing wear due to hard pumping is costing you money for frequent pulling jobs, Tuffr Rod Couplings with Thermospray Hard Surfacing can help you turn an operating expense into profit. Tuffr Polished Rods and Liners will give you the same results at the wellhead, too; your stuffing box rubbers will seal off better and last longer, and your location will be cleaner and safer.
Thermospray applies an extremely hard surface to steel so that wear caused by continuous friction will be minimal. In the process, a boride, carbide, and nickel powder is heated and sprayed onto the steel, then fused under extremely high temperature with the base metal, and finish ground to a smooth, friction-resistant surface.
Thermospray is the toughest metal you can use in your rod string. It's file-hard but not brittle, it's non-porous, and not subject to innergranular corrosion from salt water or hydrogen sulfide fluids.
The next time you run a string of rods, make up with Tuffr Couplings and a Tuffr Polished Rod or Liner and watch how Thermospray will save you needless replacement costs. You can get Tuffr through leading stores throughout the oil patch.
"BEST PUMPS IN THE OIL PATCH"
HARBISON-FISCHER
FORT WORTH
NEW from Harbison-Fischer
tuffr
POLISHED RODS
POLISHED ROD LINERS
SUCKER ROD COUPLINGS
with H-F
thermospray
HARD SURFACING

roller bearings for true axial alignment. *The National Supply Div., Armco Steel Corp.*

Circle number (15) on reply card

Paraffin Inhibitor

A complex organic formulation to inhibit paraffin deposition and to disperse existing accumulations in lines and tank bottoms has been introduced. It is said to be effective for preventing deposits in tubing, flowlines and gas lift wells, as well as an effective cleaner for stock tank deposits. It is a liquid — soluble in crudes, insoluble in water. It contains no chlorinated hydrocarbons or heavy metals and may be stored outdoors. *Hagan Chemicals & Controls Inc.*

Circle number (16) on reply card

Literature

Slush Pump Data Charts

Performance data charts on all seven Continental-Emsco power slush pumps highlight a new 12-page bulletin. Featured are cutaway views of construction features of the power end and fluid end of the slush pumps. Complete specifications and dimensions are included. *Continental-Emsco Co.*

Circle number (17) on reply card

Analogger Described

An analogger's design data and operating benefits are the subject of a new 8-page publication. Also provided is information on optional recording receivers and integrators for use with the Rockwell-Republic MP-12 analogger. *Republic Flow Meters Co.*

Circle number (18) on reply card

Meter Catalog

Descriptions, illustrations, specifications and dimensions of Rockwell's complete line of petroleum and industrial meters and accessories are presented in 28-page catalog. *Rockwell Manufacturing Co.*

Circle number (19) on reply card

Ball Valve Detailed

A catalog sheet describes in full color a new stainless steel ball valve that has been designed for corrosive fluids, gases and general corrosive services. Type 316's operation and applications are detailed. There are also cutaway views and pressure ratings. *Lunkenheimer Co.*

Circle number (20) on reply card

Spirally Grooved Drill Collar

Specifically designed to overcome problems of differential pressure sticking the drill collar string in the hole is a patented spirally grooved drill collar. A new 4-page folder enumerates its advantages and operation and gives recommendations for its general use and prices, including rental and use of the process machined on customers' own drill collars. *McClinton Tool Co.*

Circle number (21) on reply card

Storage, Disposal Well Hookups

An 8-page technical bulletin discusses the special problems of equipping storage and disposal wells and the resulting requirements for storage and disposal wellhead equipment. Typical hookups are described, and a broad line of casing heads and hangers and tubing heads and hangers are illustrated. *Oil Center Tool Co.*

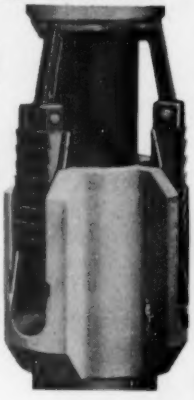
Circle number (22) on reply card

Integral Joint Tubing

Just released is a folder giving specifications and dimensions for a new 2-in. OD by 0.165-in. wall tubing that offers an integral box and pin connection at an economical

DOUBLE-E

TENSION TUBING ANCHOR



SAFE

Slip flanges shear when unable to rejay anchor for removal from well.

PROVEN

Double-E tension tubing anchors have been field proven for over seven years.

EFFICIENT

Rod and tubing wear troubles virtually eliminated, pump efficiency increased.

The unique fracture flanges on the slips, originated by Equipment Engineers, is your insurance of a positive method of retrieving the tubing.

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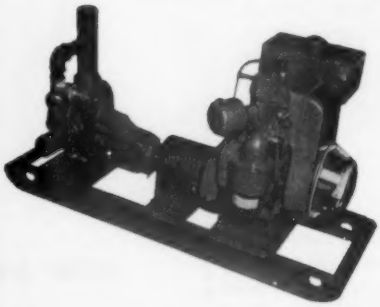
leaders for 30 years in well completion & pumping equipment

and every morning will be . . .
when you use HARSCO
Transfer Recirculating Units



ALL WEATHER OIL TREATING PUMPING UNITS

Pumping unit powered by Wisconsin air-cooled engine for circulating oil and tank bottoms. Slow speed of pump eliminates internal agitation and remulsification, it is self-priming, positive and has high suction lift. High tension rotary magneto with impulse starter insures easy starting of engine at lowest temperatures. Engine is free from those parts that cause operating troubles such as fan belts, radiator and water pump.

HARLEY SALES CO.

Wisconsin Oil Field Distributor

505 S. Main WICHITA • 619 S. Main TULSA • 3420 McKinney HOUSTON

price. It is immediately available in J-55 Range 2 tubing with N-80 available soon. Thread form is API 10 Rd. Joint efficiency is said to exceed 100%. The new joint is interchangeable with 1½-in. API EUE top and bottom connections. *Atlas Bradford Co.*

Circle number (23) on reply card

Subsurface Instrument Data

A new catalog features subsurface pressure and temperature recorders for wireline surveys of reservoirs and storage fields. Also included are gage clocks, micrometer chart readers, fishing tools, supplies, replacement parts and rental service. *The Kuster Co.*

Circle number (24) on reply card

Centrifugal Pumps Discussed

Addition of two new sizes to more than double capacity range of the Goulds model 3305-06 two-stage centrifugal pump line has produced a new bulletin on the subject. Performance curves, material specifications, interchangeability charts and dimensions of the two new units are included. *Goulds Pumps Inc.*

Circle number (25) on reply card

Packaged Field Compressors

Ready for quick field installation for such applications as gas lift are packaged field compressors, models AM-2 and AM-4. A new bulletin describes many of the special features of these compressors. Included are principal dimensions and operating data. *C-B/Southern, The Cooper-Bessemer Corp.*

Circle number (26) on reply card

Mast Erection Procedure

A new 6-page bulletin contains detailed drawings of the basic steps in the erection procedure of the T-97 trailer-mounted drilling mast. Also included is information on a special drawworks trailer and a companion substructure that may be furnished with the T-97. *Continental-Emsco Co.*

Circle number (27) on reply card

Booklet About Grease

Included in a concise, easy-to-read, 32-page summary are the basic principles, properties, types and rules for choice and application of lubricating grease. Of interest also is a summary of the effect of additives on grease properties. *Bardahl Manufacturing Corp.*

Circle number (28) on reply card

ANOTHER PRODUCT WITH PROVEN PERFORMANCE ENGINEERED BY

TIW

TYPE HDSL SNAP-LOK DUAL STRING PACKER

MOST EFFICIENT ... RUGGED ... ECONOMICAL ... PERFORMANCE PROVED DUAL STRING PACKER. CAN BE EXPECTED TO PERFORM ON FIRST RUN.

These are among the many features that make the T-I-W Type HDSL SNAP-LOK Dual String Packer first choice for dual completion efficiency: Packer can be set, released and re-set without coming out of hole by use of snap lock. Snap lock mechanisms used for positive indication when setting or tagging seal nipples. Positive acting, dove-tail slips are easily set and unset. Especially designed packoff rubbers, seat and seal easily, with minimum of weight. Setting weight on second string does not add weight to bottom packer through first string.

Get the most for your money. Let experienced T-I-W service men assist with the selection of the right equipment for your well . . . and see that you get first-run performance, with dependable T-I-W field-service installation. CALL, WRITE or WIRE for details TODAY!

Manufacturers of: T.I.W. Portable Rigs . . . T.I.W. Safety Joints . . . T.I.W. Rotary and Casing Slips . . . T.I.W. Grief Stem Safety Valves . . . T.I.W. Packers for every purpose . . . T.I.W. Pump Chambers . . . T.I.W. Mudmixers . . . and many other oil field tools.

TIW TEXAS IRON WORKS

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IN VENEZUELA: Oilfield Sales & Service, S. A., Anaco & Maracaibo
IN CANADA: Garrett Oil Tools, Ltd., Edmonton, Alberta

EB4

Exploration

CALIFORNIA

Nordon Corp. Ltd. has spudded in first well in its new 320-acre lease in the Helm oil field area of Fresno County. Francis 8-16 lies 800 ft south and 330 ft east of the north quarter corner of section 16, T18s, R17e. Projected depth is 7000 ft in the Miocene.

Occidental Petroleum Corp. tested wildcat Lathrop Unit A-1 in Sacramento Valley with a combined total stabilized test rate of 17,829,000 cu ft of gas per day. The well is located in the company's lease block of some 5400 acres on an anticlinal nose in section 5, T1s, R6e, San Joaquin County. Three intervals between 7242 and 7519 were drillstem tested. The first interval was 7242-78 ft. At the end of a 2 hr 45 min open hole drillstem test, gas flowed through a ¼-in. bottomhole bean at a daily rate of 4.059,000 cu ft. Initial bottomhole shut-in pressure exceeded 3500 psi and final flowing pressure was over 2800 psi through a ¼-in. bean. A similar 30-min test from 7563-80 ft yielded 4,935,000 cu ft of gas through a ¼-in. bottomhole bean. The third test from 7480-519 ft was the biggest. It produced a gas flow of 8,835,000 cu ft per day through a ⅜-in. bottomhole bean in 25 min. When the test was stopped at the end of 30 min, gas flow was building rapidly. Drill site is about 5 miles southwest from the southern limits of Stockton.

IRAN

The Iranian Oil Exploration and Producing Co. has spudded in well KD-One at Khalafabad, 15 miles southwest of the Agha Jari field.

MONTANA

Union Oil Co. of California made 35 bpd from a single casing notch at 3315-25 ft in the Madison Lime of No. 1 Tribal-2605, C SE SE 16-3n-36n-6w in Glacier County.

Madison was found dry at 3661-76 ft at Cardinal Petroleum Co.'s No. 1 Ryan, C SE SE 30-30n-6w. This well, 10½ miles south of the South Cut Bank field in Glacier County, was stopped at 3771 ft.

ISRAEL

Offshore prospecting rights along the Mediterranean Continental Shelf have been issued by the Israel Petroleum Council to the Canadian firm, Sancana. The company will investigate drilling possibilities in the area. part of which is a limestone reef.

NETHERLANDS

Netherlands Petroleum Co. (NAM), in which Shell Nederland N. V. and Standard Oil of New Jersey have joint interests, will carry on exploratory oil drilling 2½ miles off the coast south of The Hague.

OKLAHOMA

A big gas stepout from the West Marshall pool in Kingfisher County was completed by Oil Capital Corp.'s No. 1 Stringer, C SW SW 34-19n-5w, which is about a mile southeast of the pool. Open flow was calculated at 10,000,000 cu ft of gas per day from Oswego zone perforations at 5850-74 ft. During a 6-hr test the zone flowed 3,190,000 cu ft of gas daily with 42 bpd distillate on a 16/64 in. choke.

Bell Oil & Gas Co.'s No. 1 Warren, C NE 9-6n-11e, 4 miles northeast of the North Hilltop pool in Hughes County took a 45-min drillstem test at 3043-110 ft. Gas, which surfaced in 13 min, flowed at the daily rate of 191,000 cu ft, and recovery included 65 ft of gas-cut mud. The shutin bottomhole pressure was reported at 665 psi. The 4½-in. casing was set at 3109 ft.

Second pay was tapped by Southern Union Gathering Co. when the 5-year-old discovery No. 1 Follansbee, SW NW SW 18-9n-15e, pool opener for the Southwest Raiford pool in McIntosh County, completed the Lower Cromwell zone. Openings at 4280-300 ft yielded 4,360,000 cu ft of gas per day.

PAKISTAN

Pakistan Shell Oil Co. is drilling another well on a new structure in the Sylhet area in a search for oil in East Pakistan. This well, Kailas Tila No. 1, which is 10 miles east of Sylhet, is expected to reach a depth of about 13,000 ft.

PENNSYLVANIA

Some 90,000 acres in the Pocono Mountains of Northeast Pennsylvania will be explored for oil and gas by Pure Oil Co. About 58,000 acres of the total area were leased from the Lehigh Coal & Navigation Co. The latter lands are located in Carbon, Monroe, Schuylkill, Luzerne, Lackawanna and Wayne counties.

TEXAS

No. 2 H. A. Wimberly, 23 miles southwest of Fort Stockton in Pecos County, West Texas, has been completed by Hassie Hunt Trust and Gulf Oil Corp. as an Ellenburger gas discovery. Calculated flow is 2,675,000 cu ft per day from perforations at 10,485-535 ft.

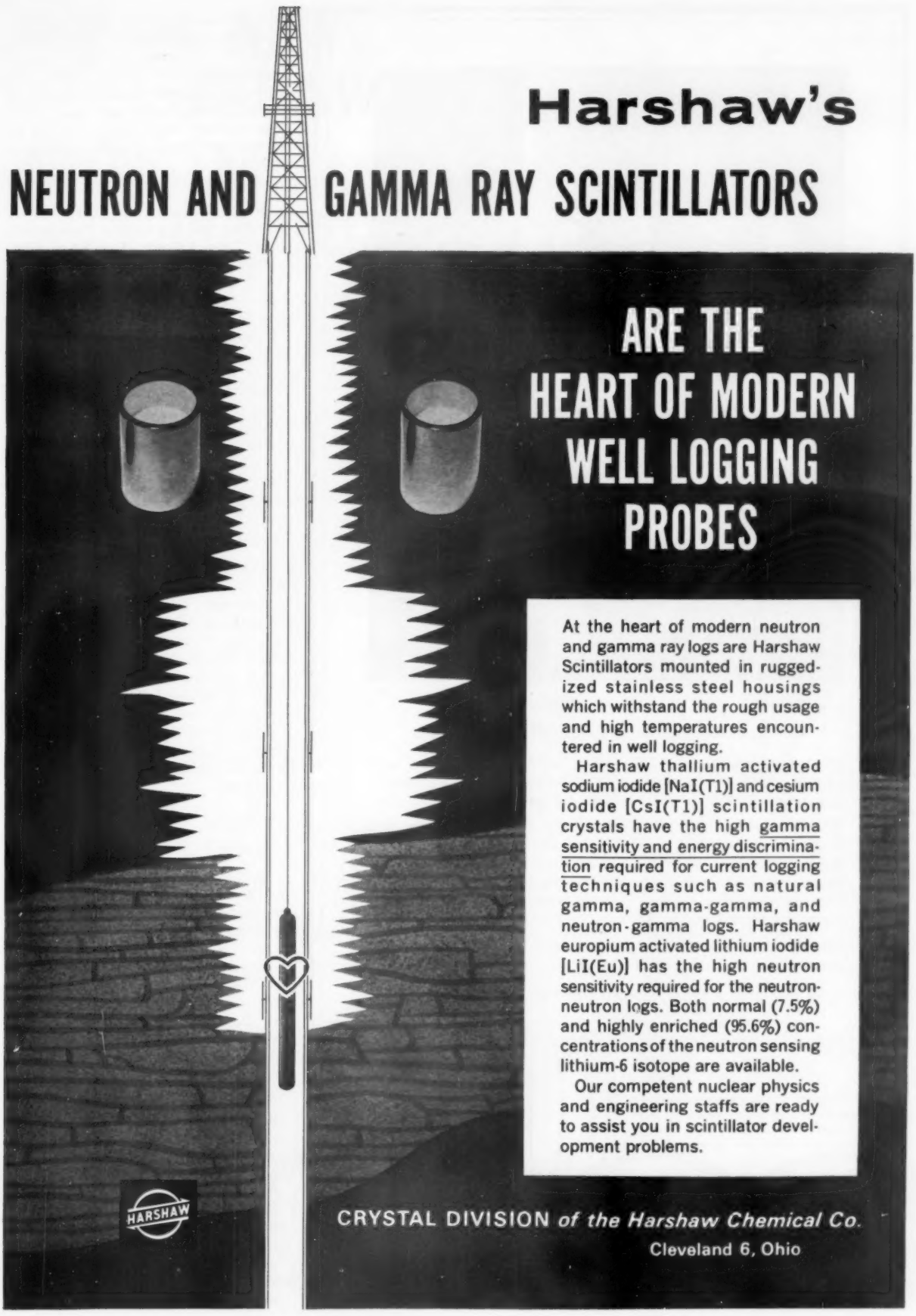
Humble Oil & Refining Co. completed its No. 1 Augustine as a small Queen sand strike, pumping 9 bpd, accompanied by about 41 bpd of water, from openings at 2352-56 ft. This well in Pecos County was originally staked as a core test.

UTAH

Delhi-Taylor Oil Corp. has completed a gas discovery in Uintah County. This wildcat, Delhi-Taylor No. 1-15 Government, has an open flow potential of 6200 Mcf per day. The well was completed in two

Harshaw's

NEUTRON AND GAMMA RAY SCINTILLATORS



ARE THE HEART OF MODERN WELL LOGGING PROBES

At the heart of modern neutron and gamma ray logs are Harshaw Scintillators mounted in ruggedized stainless steel housings which withstand the rough usage and high temperatures encountered in well logging.

Harshaw thallium activated sodium iodide [NaI(T1)] and cesium iodide [CsI(T1)] scintillation crystals have the high gamma sensitivity and energy discrimination required for current logging techniques such as natural gamma, gamma-gamma, and neutron-gamma logs. Harshaw europium activated lithium iodide [LiI(Eu)] has the high neutron sensitivity required for the neutron-neutron logs. Both normal (7.5%) and highly enriched (95.6%) concentrations of the neutron sensing lithium-6 isotope are available.

Our competent nuclear physics and engineering staffs are ready to assist you in scintillator development problems.

HARSHAW

CRYSTAL DIVISION *of the Harshaw Chemical Co.*
Cleveland 6, Ohio

how to find a 27-inch oil field at 6760 feet...

(San Patricio County, Texas) — Core analysis of side wall samples pinpointed a thin (27") oil column, among water-bearing massive sands, which is producing oil at commercial rates.

The more you see, the more you learn — *but,* if no conventional cores are taken, then an analysis of side wall samples is certainly better than no analysis at all. In this case, the operator's decision to spend a few more dollars on core analysis resulted in the discovery of an oil field — *after negative reports from other formation evaluation methods.*

Did you core and analyze your last "dry" hole? If not, are you positive you didn't miss something?

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UNITED STATES CANADA SOUTH AMERICA EUROPE AFRICA

Wasatch sands producing from perforations at 5330-5342 ft and 5036-5050 ft. The company has a working interest in some 11,500 net acres in a gross 15,000 acre block in the general area and has scheduled another exploratory test at an early date in the eastern portion of the block.

New discovery in the Lisbon trend on the Big Indian Prospect in San Juan County has been completed by The Pure Oil Co. The No. 1 Big Indian well is about 2¾ miles north of the Northwest Lisbon field. It flowed 7.4 million cu ft of gas per day with some 11 bbl of 65.6 gravity condensate per million cu ft of gas through a 29/64 in. choke. Production is from 58 ft of perforations between the 9886-10,150 ft level in the Mississippian formation. Open flow potential is calculated at 44 million cu ft per day.

WEST GERMANY

The deepest oil deposit found so far in Western Germany has been discovered in the area between Rosenheim and Munich. The well, Assling 1 of Mobil Oil-Gewerkschaft Elwerath-Preussag drilled 20 miles southeast of Munich near Assling, struck oil in the Priabon sandstone of the Tertiary at a depth of 11,307 to 11,359 ft. Production tests yielded a free flow of 176 bpd of light oil through a ⅛ in. choke.

WYOMING

A drillstem test at Sam Gary's No. 1 Fowler, C SW NW 7-54n-67w, wildcat in Crook County, in the northeast, recovered 5220 ft of clean oil of the Minnelusa pool at 6034-50 ft. Top of the pay was 6019 ft. Taking over the well, Shell Oil Co. will complete the strike located on the east flank of the Powder River Basin.

The Wind River Indian Agency, Fort Washakie, gives notice that certain tribal Indian lands will be advertised for oil and gas leases around Jan. 20, 1962. Lands to be advertised for the Sale No. 6 are within: T6n, R2w; T7n, R3e, T7n, R4e; T8n, R3e; and T8n, R4e. Interested parties can secure prospecting permits for further exploration from this Wyoming agency of the Bureau of Indian Affairs, Department of the Interior.

NEW...
THE SWACO
GOLDEN CLONE
CLAYJECTOR®

Three major improvements result in more stable operation, greater ease of adjustment and virtual elimination of plugging.

New Golden Clone* cyclones feature a ceramic lining so wear-resistant that clone dimensions so essential to efficient operation remain unchanged even after months of use.

New pressure regulator for feed holds uniform correct pressure on cyclones. Single valve adjustment of dilution simplifies operation.

New SWACO Auto-Screen* prevents plugging of unit with drilled solids, lost circulation materials or trash.

These improvements have added greatly to the already outstanding performance of the Clayjector. If you are drilling with mud heavier than 12 pounds per gallon, you can cut mud costs by using the Clayjector. Ask a SWACO representative for full information.

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LOUISIANA: New Orleans, Lafayette • TEXAS: Houston, Corpus Christi, Fort Worth, Kermit • OKLAHOMA: Oklahoma City • NEW MEXICO: Farmington

Suppliers' Parade

Neil Miller, treasurer of Dowell Div. of the Dow Chemical Co. died. He spent 12 years in accounting and auditing work before joining Dowell in 1936 as an accountant. He was promoted to assistant secretary-treasurer and auditor in 1941 and became treasurer in 1959.

Brown Oil Tools Inc., developer of new multiple completion methods and equipment, has signed a patent licensing contract with Baker Oil Tools Inc. Under the agreement, Baker has acquired non-exclusive license to use and sell such multiple completion methods and equipment under patents issued to Brown.

Clark Bros. Co., Div. of Dresser Industries, Inc., has opened an office in Buffalo, N.Y. Charles P. Clark Jr. is in charge of this branch of the Pittsburgh office. Prior to being transferred to Buffalo, he was sales engineer with the Pittsburgh office.

Collins Radio Co. has integrated all microwave activities into one organization within its new systems division, the Alpha Corp. New director is Kerry R. Fox. Appointments in the new microwave systems division under Fox include R. S. Willard, manager of microwave sales; L. M. Fisher, manager of microwave systems engineering; and H. G. Kraft, business manager for microwave contracts.

The gravity department of Geophysical Service Inc. moves from Houston to Dallas, Tex. Dr. Richard A. Geyer, manager of gravity operations, will continue in this position in Dallas.

Two new inspection divisions have been opened by Tuboscope Co. One, located in Carmi, Ill., is managed by C. E. Shake, formerly Houma, La., division manager. The other is in Graham, Tex., and is supervised by Wendell Harrison, who was previously production manager in Odessa, Tex.

Wheel Trueing Tool Co., Detroit, Mich., has acquired Drilling and Service Inc. of Dallas, Tex. Since 1946 the Texas firm has been the world-wide sales and service outlet of Wheel Trueing in the oil field drilling industry. Terms of the transaction were not disclosed.

Bucyrus-Erie Co. has sold the manufacturing and marketing rights of the Winkie drill to the international firm of J. K. Smit & Sons. The first-named company acquired the rights to produce the drill in 1958 from the Wink Corp.

Target **Longer Service**

TYPE 30 — Carbon-Manganese fully normalized. For heavy duty where corrosion is not a major problem.

TYPE 40 — Nickel-Molybdenum Alloy. Normalized and tempered. For heavy duty pumping in medium corrosive conditions.

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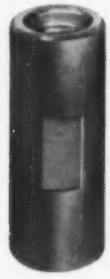

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To: Greatly Reduce Coupling Wear in Crooked Holes

To: Greatly Reduce Tubing Wear by Couplings in Crooked Holes

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* Ask for BMW Armorcote a hard corrosion and wear resistant overlay that won't pit, peel or ravel.

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Excell Specialty Co.
Edmonton, Alberta, Can.

L. C. Laycock

Roots-Connersville Blower, Div. of Dresser Industries Inc. has opened a new branch office in Midland, Tex. LeRoy C. Laycock, formerly of the Houston office, is branch manager.

Appointments and Promotions

Clark Bros. Co. — has appointed sales engineers: M. S. (Mel) Kenady, Amarillo; Z. B. (Zobo) Deer, Tulsa; Edward S. Leonard, Houston; Thomas R. Bett, Shreveport.

Continental-Emsco's Fibercast Co. — Philip J. Liston, sales manager.

Camco Inc. — Charles H. Weier, financial vice president and secretary, Houston, Tex., formerly with Mortgage Associates Inc.

Daniel Orifice Fitting Co. — B. C. McKnight, district sales representative, Dallas, Tex.

Dowell Div., Dow Chemical Co. — William M. Ross Jr. petroleum engineer, from Hobbs, N. Mex., to Tulsa, Okla., general offices.

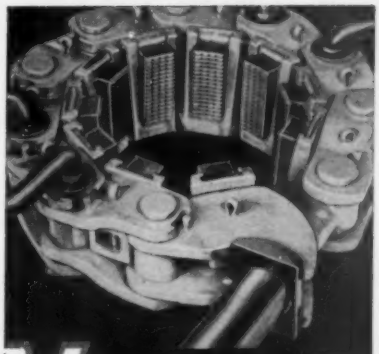
Alten Foundry & Machine Works Inc. — William A. Morris, chief engineer.

Atlas Bradford Co. — L. T. Shackelford, district sales manager, Houston; W. L. (Bill) Phillips, Louisiana-Mississippi district sales manager, Lafayette, La.; Roger E. Bartelsmeyer, district sales manager for West Texas, Odessa, Tex.

Bowen Itco Inc. — Z. C. Ambrose, general sales manager, Houston, Tex., formerly executive vice president, Houston Oil Field Material Co.

Dresser Industries Inc. — John P. Cartwright, elected vice president, machinery group, formerly vice president and general manager, industrial division, Joy Manufacturing Co.

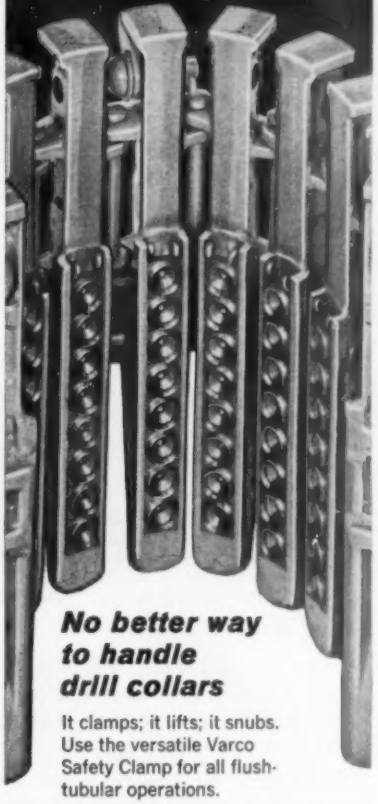
Dresser Manufacturing Div., Dresser Industries Inc. — Harry R.



Varco

SAFETY CLAMP

TYPE DCS SLIPS



No better way to handle drill collars

It clamps; it lifts; it snubs. Use the versatile Varco Safety Clamp for all flush-tubular operations.

Use it especially in combination with Varco Type DCS Slips (with extra long back) for easier, safer handling of drill collars.

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MIDCONTINENT OFFICE: HOUSTON, TEXAS

Castle, sales representative for Michigan, Northern Indiana and Western Ohio, formerly district manager for Lincoln Engineering Inc.

Geolograph Service Corp. — Travis W. Brown, manager of field operations, Oklahoma City, Okla.

Oil Center Tool Co. — Walter Burke, senior city salesman, Houston, Tex.; Buddy Fletcher, South Texas district manager, Corpus Christi; Larry G. Tigert, sales and service representative, Oklahoma City, Okla.

Guiberson Corp., one of the Dresser Industries — Gordon G. Guiberson, elected chairman of the board; Robert L. Boyd, appointed president; Jack W. Edwards, manager of purchasing; Dale E. Johnson, manager of exports; Dennis L. McGill, manager of advertising; Hal Messinger, director of marketing.

Hughes Tool Co. — H. E. Collins, director of licensee manufacturing services.

Jones & Laughlin Supply Div. — James A. Bailey, sales supervisor — LACT in production equipment sales section, Tulsa, Okla.; district store managers — Julius Nemeth, Morgan City, La., from salesman, Harvey, La.; and W. H. Seeker Jr., Hobbs, N. M., who is succeeded as store manager at Snyder, Tex., by Haney Atyia, formerly salesman, Midland, Tex.; in tubular products department — E. F. Westhoff, assistant to merchandise manager; B. F. Harrod, chief clerk; and salesmen — F. P. Crahan, Hennessey, Okla.; D. L. Dutton, Harvey, La.; and R. D. Leslie, Hobbs, N. Mex.

Mission Manufacturing Co. — C. E. Van Loozen, industrial sales manager, formerly western district manager; F. J. Herbert, western district manager, formerly southeastern district production sales representative, with Harold Herren replacing him in the southeast; Melton Wright, sales administrator; Johnny Warren to packaged gas turbine, Round Power, sales.

Oil Well Supply Div., U. S. Steel Corp. — store area sales representatives: Donald G. Kiihn, Cut Bank, Mont.; Robert W. Anderson, Vernal, Utah; Gene H. Stumpf, Gillette, Wyo.

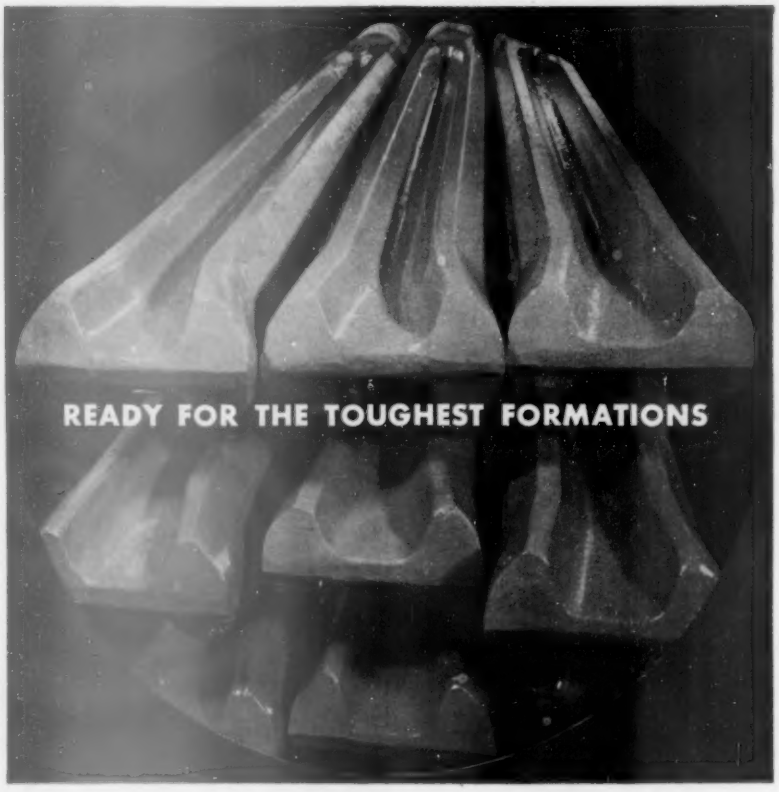
Plastic Applicators Inc. — Herbert Alexander, western division sales manager, Midland, Tex., formerly sales representative in Odessa.

Republic Supply Co. — J. C. Bergin, vice president in charge of operations and directing the activities of all supply districts, stores and sales office, formerly South Louisiana district manager; and Jack R. Wright, vice president in charge of sales, formerly manager of project and industrial sales.

Worthington Corp. — Peter S. Barno, elected vice president, employee and public relations, formerly vice president for public and industrial relations, Chase Brass & Copper Co. Inc.; Patrick L. McManus, appointed general manager, Standard Pump Div., formerly director of marketing services.

Schlumberger Well Surveying Corp. — T. I. Obenchain, senior sales engineer, Farmington, N. M.; O. Wayne Burnett, sales engineer, Newcastle, Wyo.; D. C. Ross, location manager, Abilene, Tex., S. R. Harris, location manager, Effingham, Ill.

Tretolite Co., division of Petrolite Corp. — James W. Hakeman,



THE DIFFERENCE SHOWS UP IN PERFORMANCE!

What's the difference? PROVEN PERFORMANCE . . . in more footage . . . fewer dressings . . . less rig down time! That's the record of SPANGALOY bits after months of field tests conducted under the toughest drilling conditions.

SPANGALOY bits are made of a special alloy. This, plus improved heat treatment, results in greater tensile strength and yield to withstand the torque, impact, vibration and abrasion encountered in the hardest and most irregular formations.

Specify SPANGALOY bits on your next order.

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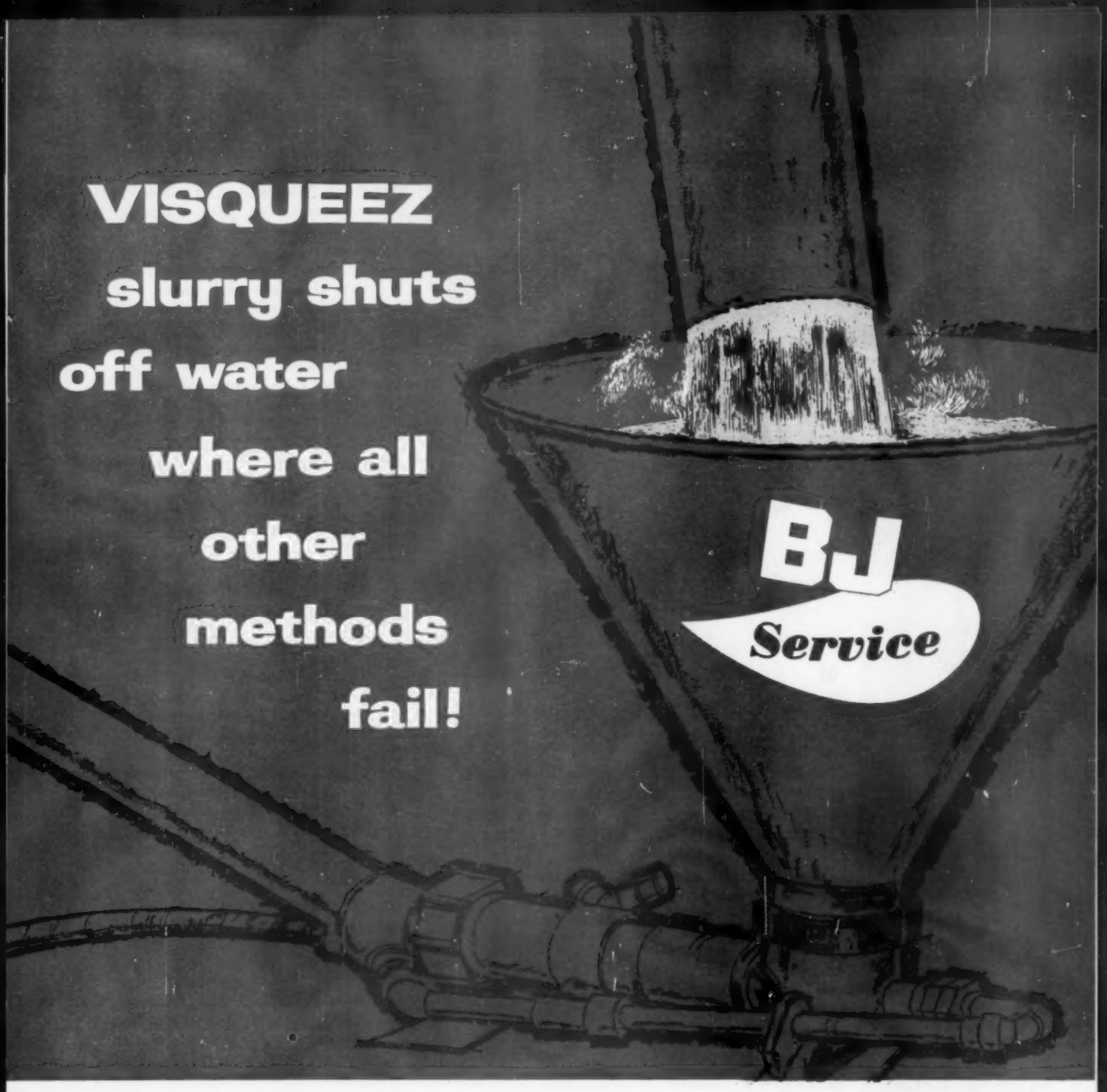
SPANG & COMPANY · BUTLER, PA. / BRANCHES: Bolivar, N. Y., Mt. Pleasant, Mich., Winfield, Kan.



An exclusive BJ Service development, Visqueez is the most effective method yet devised to shut off water from producing oil or gas wells. Only Visqueez slurry *thins* on contact with water... penetrating and depositing cement deep into the most troublesome water-bearing formations. A special viscous carrying agent puts a protective coating around the cement particles. The slurry cannot set up until a *pre-timed* chemical action removes the oil coating. No high squeeze pressures... no need for reverse circulation or costly drilling out—excess slurry is recovered as free-flowing oil and cement. With BJ Service Visqueez, the well is back on production in 24 hours or less!

For complete details, call your local BJ Service field station today.

Results talk!

Visqueez Increases Oil Production 30% – Decreases Water Production 27%

PROBLEM: To lower the water/oil ratio of the producing wells in a water-flood system in Wyoming. SOLUTION: Visqueez was used to treat 16 producing wells with an aggregate production of 10,883 BWPD and 897 BOPD. Following Visqueez treatments, water production has decreased to 7,983 BPD and oil production has increased to 1,169 BPD. Over-all results: water production down 27% – net oil production *up* 30%.

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Bottom-Hole Pressure Gauge

Dependability of Product Ball Brothers' Pressure Sentry MK-7, for pumping, flowing, or shut-in wells, is permanently installed below the pump. Digital signals from a Bourdon tube-coded wheel assembly are sent up a single conductor wire to assure a ± 1% pressure readout accuracy. Readout is not influenced by absolute value of current or resistance of wire. A simple, portable surface unit makes a permanent record of reservoir pressures on chart paper.

Continuous, intermittent, or automatically timed pressure recordings may be made. Available in pressure ranges to 8000 psi. Will operate in wells with temperatures to 275°F.

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BOULDER INDUSTRIAL PARK — BOULDER, COLORADO
A Subsidiary of Ball Brothers Company, Inc.

assistant to general sales manager, St. Louis, Mo., formerly assistant Rocky Mountain division sales manager, Edmonton, Alta., Canada; and new field service engineers — Jerry Worsham, Levelland, Tex.; Joe W. Moore, Odessa, Tex.; Billy Johnson, Corpus Christi, Tex.

Well Equipment Mfg. Corp. — William G. Meinecke, sales and service, Hobbs, N. M., formerly a geologist for Darrell W. Smith Co.; and H. M. Williams, industrial sales, Houston, Tex., formerly a steel warehouse sales representative in the Houston area.

Reed Roller Bit Co. — Roy A. Bobo, to the newly-created post of sales engineering manager.

A Pair of Corrections

On page 71 of the October issue, in the next to last paragraph, appears the statement "It is significant to note that since there is no limitation on bit efficiencies, the smaller diameter burner or 'bit' drills faster." Reference was made to Fig. 4 which appeared on page 72. Since this curve pertains to performance of Linde's model 6T36 burner, the above statement is not entirely correct. The curve indicates the hole size and not burner size. This curve in Fig. 4 does show that as the burner penetrates zones of poor "spalling" characteristics, the average diameter of the hole becomes larger.

In September, a reference was listed on page 54 showing H. L. Saunders associated with Linde Co., Div. of Union Carbide Corp. Mr. Saunders was and is associated with Aluminum Laboratories Ltd., of Kingston, Ontario, Canada. Both errors are regretted.

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What's doing in Drilling

Breaking Rock Electrically

Rock can be broken electrically. A way to do that has been successfully tested jointly by the Montana School of Mines and Westinghouse Electric Corp. The main piece of apparatus used was a radio-frequency generator similar to a small but powerful radio transmitter. In this case, however, the generator sends its power through wires to the rock, instead of through the air via an antenna.

The concentrated high frequency current heats a path through the rock and expands it more than the unheated areas. The differential expansion causes the rock to crumble. Water present in small amounts in the rock helps the process.

Because the rock crumbles gradually instead of disintegrating violently, this electric method is decidedly safer than drilling and using explosives.

A grant was made to the Montana School by Anaconda Co. to do research on this work.

Drilling Department Changes at Kerr-McGee

Several organizational changes have been made in the drilling department of Kerr-McGee Oil Industries, Inc.

J. Norman Baxendale, formerly regional drilling superintendent of the Mid-Continent and Rocky Mountain region, has become the assistant manager of foreign operations.

John Cox has assumed the duties of chief engineer and manager of domestic land drilling operations. He was formerly in charge of engineering and maintenance in Morgan City, La.

Taking over Cox's engineering duties in the Gulf Coast is Marvin Bender, regional drilling engineer.

C. D. Blanchard, who was formerly a toolpusher, has become assistant Gulf Coast drilling superintendent.

Big Drilling Program in British Columbia-Alberta

An oil drilling program, said to be one of the biggest ever to be undertaken in the Alberta-British Columbia northland, has started in the Boundary Lake field of the Peace River country. Over 130 wells are to be drilled in the next 7 months by several companies. If the program is successful, the Boundary Lake area will become the biggest oil field in British Columbia.

Imperial Oil is a leader in the program. The company plans at least

5 months of sand production fail to damage

CAMCO

Straight-Thru Design

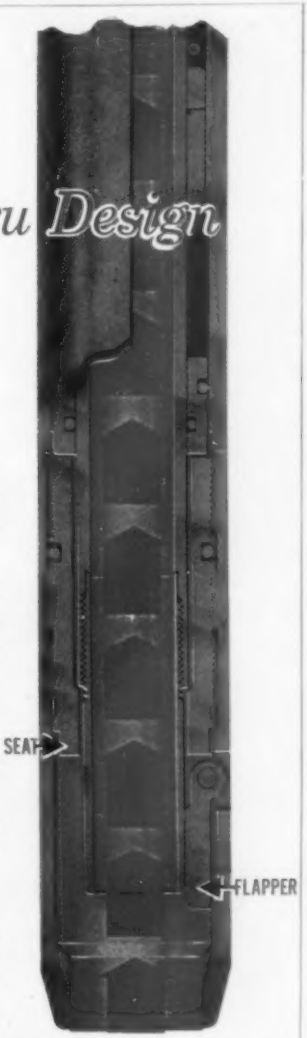
A2 Tubing Safety Valve

In a South Louisiana well, heavy sand production had repeatedly cut out subsurface tubing safety valves of conventional design, necessitating replacement every 60 days.

Then a Camco *Straight-Thru* design A2 Safety Valve was installed. By its large straight bore and by location of the flapper and flapper seat outside the flow stream, *Straight-Thru* design reduces flow turbulence and protects vital seating surfaces against sand cutting. Pulled from the sand-producing well five months after installation, the Camco A2 Safety Valve was found to be in perfect condition—ready for further duty!

Constant operating readiness for long periods of service makes the Camco *Straight-Thru* A2 your most reliable, positive assurance of automatic shut-in if surface controls should fail.

For your copy of Camco's new 28-page A2 Safety Valve Brochure, call your Camco representative or write



Straight-Thru design reduces turbulence, protects valve seating surfaces against abrasion, assures proper closure of valve at predetermined pressure drop.

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CP SUPPLIES "HOLE" PACKAGE

A single call to a CP Field Representative will get you one or a dozen different oil tools . . . the right bits for any formation – Regular, Jet or *Slant*-Jet . . . Drill Collars, Reamers or Hole Openers. Just get your CP man on the 'phone . . . day or night. He knows the moment you call that you mean now . . . *at the rig* . . . he won't spare the horses. Depend on CP to supply the "Hole" Package.

At CP we know that you've "no time for downtime!"

CP BITS *are at their best when the going gets tough . . . that's why the next bit going into the hole should be CP!*

Chicago Pneumatic
FORT WORTH, TEXAS

BITS • DRILL COLLARS
REAMERS • TOOL JOINTS

42 wells this year and may drill as many as 90 in the next 7 months at an estimated cost of $1,250,000.

Other oil companies plan a total of 38 wells in the field. Working with Imperial are Scurry-Rainbow, Pacific Petroleum, and Calvan oil companies.

Northland Foothills Agreement—British American, Shell, Mobil, and Texaco—plans 8 wells. Actual tests are divided up between Dome, Amerada, Sun, Sinclair, Hudson Bay, and Union oil companies.

Ruling May Stop Small Tract Drilling

Small tract drilling for both oil and gas could come to an end in Texas because of a recent ruling made by the Railroad Commission, the state's regulatory agency. The order divides output entirely on the basis of the acreage of each well. Thus, it has reversed the previous formula whereby two-thirds production was shared according to well acreage with the remainder divided equally without regard to tract size.

The actual ruling applied to the case of natural gas production from the Normanna field in Bea County on the Gulf Coast. Although it referred only to gas there, industry speculation is that a similar ruling for oil fields could be forthcoming.

Strict acreage allocation could make it uneconomical to drill most small tract wells. To obtain higher permitted output to make a well possible, owners of areas under 100 acres in size must prove that owners of adjacent tracts refuse to pool their interests on a fair basis.

A major oil company official believes that, under the new order, it is unlikely there will be many small tract wells in the future. He adds that in most cases producing companies will take small tract owners into pools.

New Island in Gulf Waters

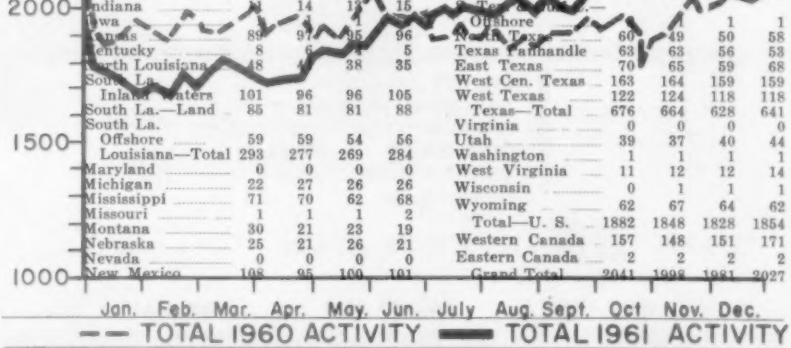
One of the largest of the man-made islands built by the oil industry in the Gulf of Mexico went into operation when Shell Oil Co. began drilling a new well in its West Delta Block 32 field. The drilling of 12 di-

Rotary Rigs Operating in Oil Fields of United States and Canada

As reported to American Association of Oil Well Drilling Contractors by Hughes Tool Company

	Sept. 4	Sept. 11	Sept. 18	Sept. 25
Alabama	6	6	5	3
Alaska	12	13	14	14
Arkansas	10	12	13	15
Arizona	0	0	1	1
California—Land	73	75	87	90
Calif.—Offshore	5	3	3	4
Calif.—Total	78	78	90	94
Colorado	31	29	30	32
Florida—Land	0	0	0	0
Florida—Offshore	2	2	2	1
Florida—Total	2	2	2	1
Georgia	1	0	0	0
Illinois	43	48	55	50
Indiana	11	14	13	15
Iowa	1	1	1	1
Kansas	89	91	95	96
Kentucky	8	6	4	5
North Louisiana	48	47	38	35
South La. Inland Waters	101	96	96	105
South La.—Land	85	81	81	88
South La. Offshore	59	59	54	56
Louisiana—Total	293	277	269	284
Maryland	0	0	0	0
Michigan	22	27	26	26
Mississippi	71	70	62	68
Missouri	1	1	1	2
Montana	30	21	23	19
Nebraska	25	21	26	21
Nevada	0	0	0	0
New Mexico	108	95	100	101

	Sept. 4	Sept. 11	Sept. 18	Sept. 25
New York	1	1	1	1
North Carolina	1	1	1	1
North Dakota	13	12	14	14
Ohio	9	9	9	7
Oklahoma	217	215	216	207
Oregon	0	0	0	0
Pennsylvania	10	10	10	11
South Dakota	0	0	0	0
Tennessee	0	0	1	1
S. Tex. & Gulf C.—Inland Waters	7	9	11	11
S. Tex. & Gulf C.—Land	189	189	174	173
Tex[illegible]—Offshore			1	1
North Texas	60	49	50	58
Texas Panhandle	63	63	56	53
East Texas	70	65	59	68
West Cen. Texas	163	164	159	159
West Texas	122	124	118	118
Texas—Total	676	664	628	641
Virginia	0	0	0	0
Utah	39	37	40	44
Washington	1	1	1	1
West Virginia	11	12	12	14
Wisconsin	0	1	1	1
Wyoming	62	67	64	62
Total—U. S.	1882	1848	1828	1854
Western Canada	157	148	151	171
Eastern Canada	2	2	2	2
Grand Total	2041	1998	1981	2027

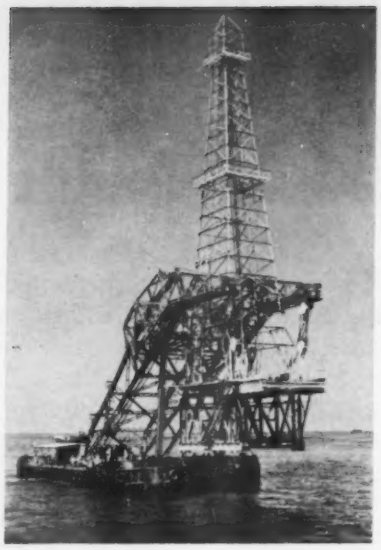


rectional wells from the combination drilling and production platform is called for under present plans. As the wells are brought in, their oil will be processed to be carried by gathering lines to on-shore installations. No oil will be stored on the platform.

The large platform covers over a third of an acre. Designed by Shell engineers, it was built by J. Ray McDermott & Co., Inc. at their Bayou Boeuf yard at Morgan City, La. In assembling the structure, McDermott made one of the heaviest lifts ever attempted in offshore Gulf waters. Two 250-ton cranes positioned a 450-ton foundation jacket. A 265-ton jacket was placed next to it. The two jackets were capped with three sections of deck. The new platform has facilities to house 42 men.

Floating Crane Moves Huge Equipment

This floating crane saves time and labor in moving huge pieces of equipment from one location to another. Here on the broad waters of Lake Maracaibo, Venezuela, it is



carrying a derrick and drilling platform to a new drilling site.

Known as the Atlas, the diesel-electric crane was built for Compania Shell de Venezuela Limited in the Netherlands and towed 4500 miles across the Atlantic by a Dutch tug.

It eliminates dismantling a rig when drilling has ended at one site and re-erecting it again on a new location. By so doing, the Atlas allows more holes to be drilled over a given period.

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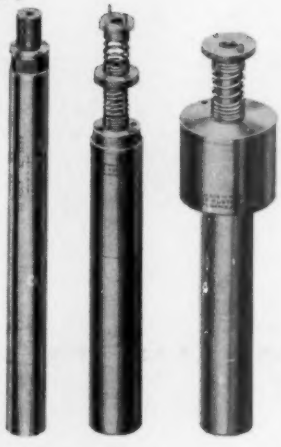

K-3 RPG-3 AK-1

Kuster Gauge Clocks are known around the world by their rugged, accurate and dependable service for 25 years under all conditions — including 500°F steam wells and in the sub-zero Arctic.

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Equation Subscript Makes Difference

Type-writing complex equations is not easy, as any secretary will tell you. This difficulty also applies when setting type to print such complex equations. In the article "Curve-Fitting Cuts Material Balance Calculations" by L. T. Stanley published in the August issue, Equation 2 under the heading "Estimating Procedure" was incorrect. It should have been written as:

$$2.\ \text{Calculate} \sum_{i=1}^{n_1} (\Delta\bar{p}_i)\ (\bar{t})^{0.8}_{n_1+1-i}$$

and

$$\sum_{i=1}^{n_1} (\Delta\bar{p}_i)\ (\bar{t})^{0.5}_{n_1+1-i}$$

The same subscript correction applies under column (9) of Table 2.

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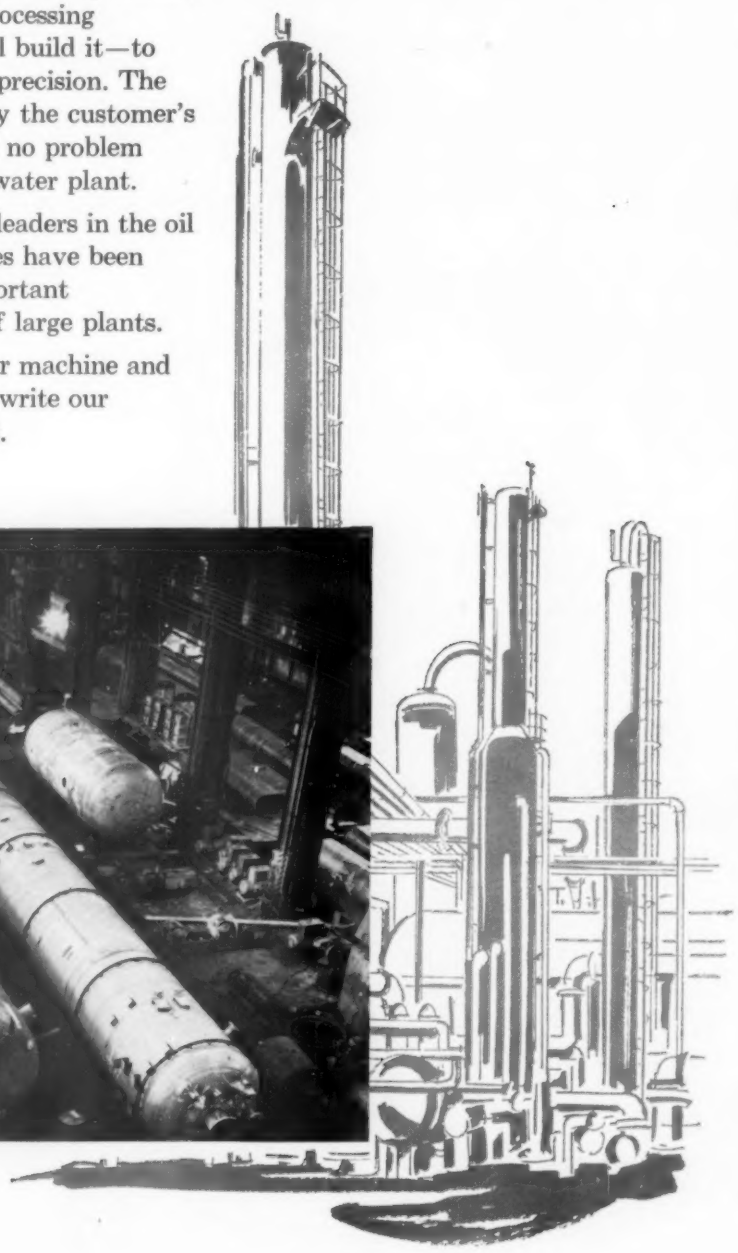
Debutinizers, exchangers, fractionating towers, pressure vessels or intricate processing equipment—you name it; we'll build it—to your requirements with exact precision. The size or shape is limited only by the customer's desire. Delivery on schedule is no problem by rail or water from our tidewater plant.

For forty years engineering leaders in the oil refining and chemical industries have been calling upon Sun Ship for important components for the building of large plants.

Let Sun Ship help solve your machine and equipment problem. Phone or write our Sales Engineering Department.



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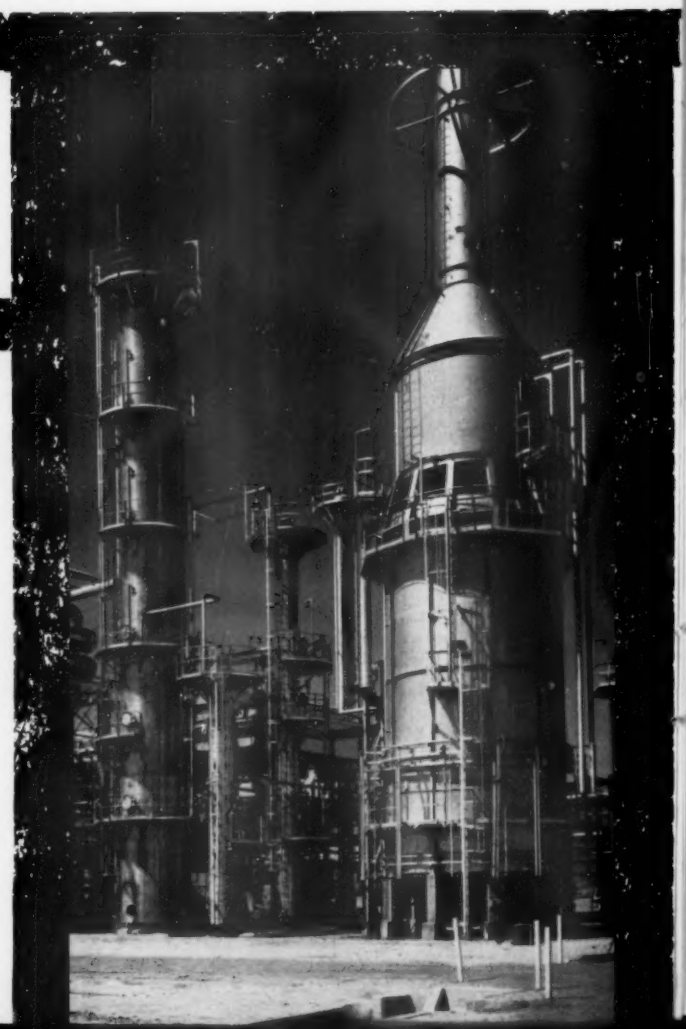
Procon completes African refinery 4 months ahead of schedule

Sixteen months to build a refinery in Mozambique . . . on the east coast of Africa near the port of Lourenco Marques . . . at considerable distances from the industries where almost all the refinery equipment had been constructed.

But build it Procon did! Not in 16 months—but in 12 months. Four months ahead of schedule! A modern 12,000 BSD refinery, it includes Platforming®, Unifining®, Merox™, and crude distillation units plus complete supporting facilities.

On stream for Sociedade Nacional de Refinacao de Petroleos (SONAREP) a subsidiary of the Portuguese petroleum marketing firm, Sociedade Nacional de Petroleos (SONAP), this refinery is another tribute to Procon's proven capabilities... to tackle the toughest job ...and complete it in the shortest possible time.



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CARACAS, VENEZUELA

Construction Briefs

Key contracts awarded to:

Fluor Corp., for engineering, purchasing and construction of benzene extraction facilities for Mobil Chemical Co. at Beaumont, Tex. Included are a 2300-bpsd Hydrotreater and a 12,500-bpsd Udex unit.

Badger Manufacturing Co., for design, engineering and construction of a 30,000,000-lb-per-year phthalic anhydride plant for Oronite Div., California Chemical Co., at Perth Amboy, N.J. California Oil Co., Eastern Div., will operate the plant.

Crawford & Russell Inc., for design of Tenneco Chemical Co.'s 200,000,000-lb-per-year vinyl chloride monomer plant on the Houston Ship Channel.

Delta Engineering Corp., for Continental Oil Co.'s natural gasoline plant in the Sacatosa field in Maverick County, Tex., to process 2.5 MMcf of gas per day and produce some 18,000 gal daily of propane, butane and gasoline.

Procon, Inc., for modifications to process units of Great Northern Oil Co.'s Pine Bend, Minn., refinery, to cost over $1,000,000. Project is designed to produce more gasoline and less fuel oil from the same crude throughput, which now averages about 39,000 bpd.

Catalytic Construction Co., for installation of hydrodealkylation facilities at Cities Service's new 50,000,000-lb-per-year naphthalene plant at the East Chicago, Ind., refinery. Plant will employ a hydrodealkylation process licensed by Union Oil Co. of California.

Early Co., for construction of a gas processing plant at Beaumont, Tex., for Port Gas Processing Co., a wholly owned subsidiary of Hudson Gas & Oil Corp.

Procon, Inc., for engineering and construction of a multi-million dollar, 40,000-bpd refinery in Thailand to supply the entire petroleum requirements of the country. Plant will be operated by Thai Oil Refinery Co., Ltd., a private company of Thailand.

Foster Wheeler, Ltd., for design, engineering and procurement and construction of a 70,000-bpd refinery at Reunion Rocks, Republic of South Africa, for South African Petroleum Refineries Pty., Ltd., jointly owned by British Petroleum Co., Ltd. and the Royal Dutch Shell Group.

Procon, Inc., for engineering and construction on a turn-key basis of a complete 10,000-bpd refinery at Manila, Philippines, for Filoil Refinery Corp., a Philippine oil concern in which Gulf Oil has a partial interest. Procofrance is handling mechanical design, purchasing, expediting and shipping of materials.

Catalytic Construction Co., for construction work to increase capacity of the alkylation unit at Atlantic Refining's Port Breeze refinery from 5500 to 7500 bpd.

California Research Corp., for process design engineering on a 6450-bpd Isocracking unit at the new refinery being built by Caltex Oil (Germany) GmbH at Frankfurt/Main, Germany.

Other new projects announced:

Commonwealth Oil Refining Co.'s initial venture into petrochemicals, a $6,500,000 plant adjacent to the Ponce, Puerto Rico, refinery, for production of naphthalene and other petrochemicals including aromatics. Plant will have a capacity of 50,000,000 lb per year of naphthalene. UOP's Hydeal process will be utilized.

Olin Mathieson Chemical Corp.'s multi-million dollar plant at its Doe Run complex in Brandenburg, Ky., to produce synthetic glycerin by a new and economical method developed by the Olin Organics Div. Capacity will be more than 40,000,000 lb a year.

Sun Oil's $2,200,000 expansion of propylene production facilities at the Marcus Hook, Pa., refinery. Design capacity will be increased by 150% to 180,000,000 lb per year.

Universal Oil Products Co.'s new plant at McCook, Ill., a Chicago suburb, to have annual capacity of more than 1,000,000 lb of a new rubber additive.

Banquete Gas Co.'s gasoline treating plant in Goliad County, Texas, to extract 9600 gal of natural gasoline, butane and propane from a throughput of approximately 10 MMcf of natural gas per day. Plant is being constructed in partnership with Houston Natural Gas Production Co. Banquete is a division of Crestmont Consolidated Corp.

Texaco Canada's expansion of the Port Credit, Ont., refinery of its subsidiary, Regent Refining, Canada, Ltd., to 35,000 bpd from the present 26,000 bpd. Cost will be $3,800,000.

Gelsenberg Benzin's 40,000 to 50,000-bpd Bavarian refinery near Neustadt, 20 miles from Ingolstadt. The company has acquired option on a site.

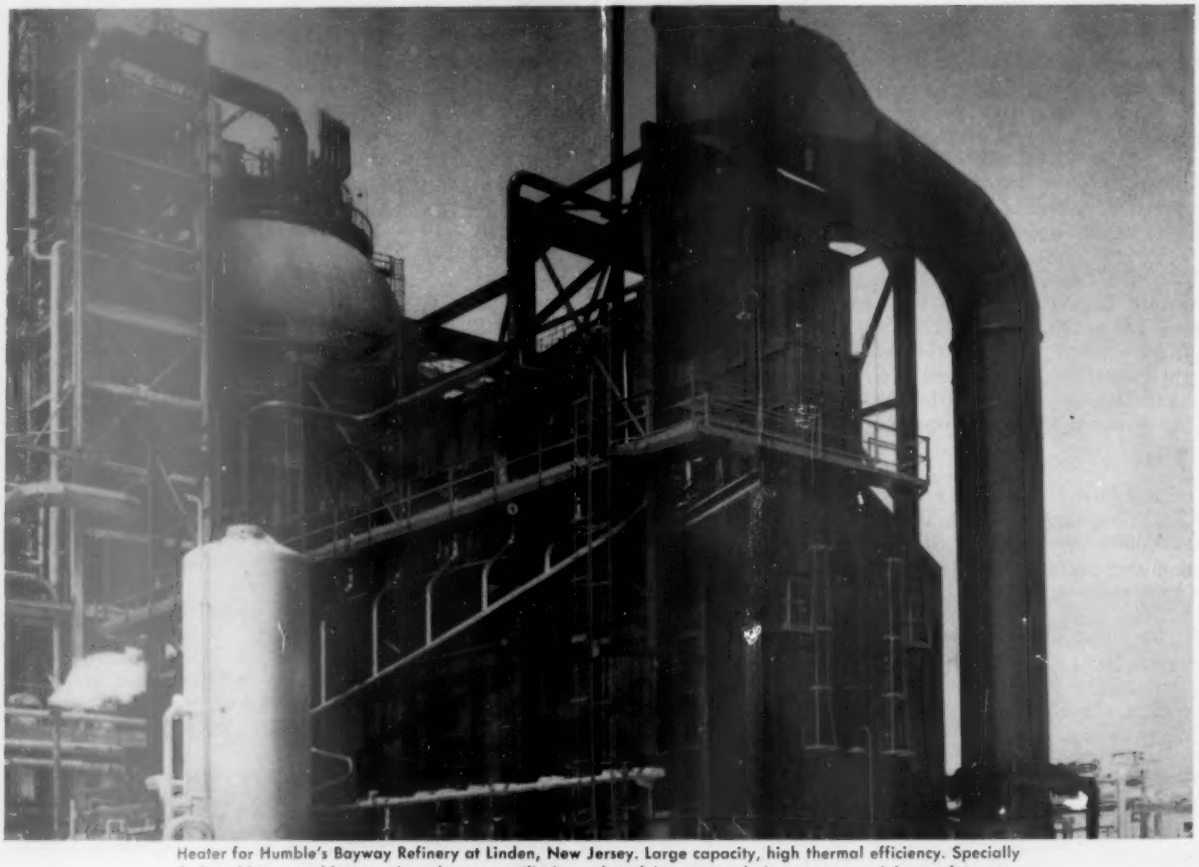
Societe des Elastomeres de Synthese's cis-polybutadiene plant, the first in France. The French-American company groups Saint-Gobain and Shell with Cabot, Texas Butadiene and French tire producers. Annual capacity of plant will be 20,000 metric tons.

Calvo Sotello's refining-petrochemical complex at Puertollano, in South Central Spain. The company is a subsidiary of state-owned INI.

Soc. Africaine de Raffinage's 14,000-bpd refinery in Senegal, backed by the French government, a French Senegalese bank and the six major companies who market in the country. The majors (Shell, Mobil, Esso, Texaco, British Petroleum and Cie. Francaise de Petroles) will have a 60% interest in the company.

LUMMUS

ENGINEERS AND CONSTRUCTORS FOR INDUSTRY



Heater for Humble's Bayway Refinery at Linden, New Jersey. Large capacity, high thermal efficiency. Specially designed integrated heater, air preheater, auxiliaries and stack in compact design to occupy minimum plot space.

Lummus Oil Heater for Humble's Bayway Refinery meets three tough design requirements

LARGE CAPACITY, HIGH EFFICIENCY, LONG RUNS

Humble Bayway knew exactly what they wanted in a replacement heater and turned confidently to Lummus to meet their difficult design requirements.

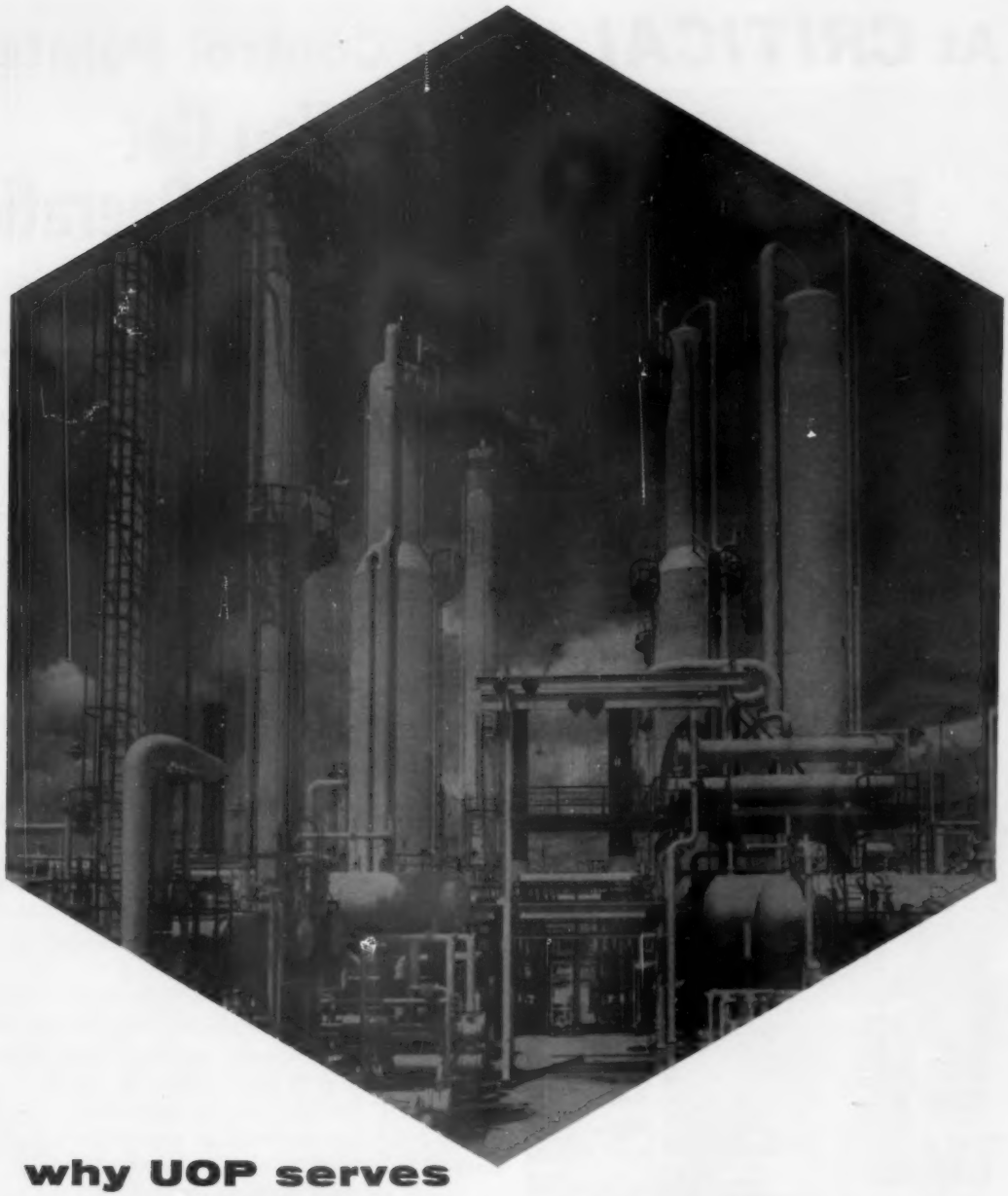
First, the heater had to be large enough to service this giant Cat-Cracker; now one of the largest in operation.

Secondly, Humble wanted a high thermal efficiency, 86% as compared with the usual 75-80%. In the Lummus design, the heater utilizes Ljungstrom Air Preheater and integrated blower and duct system to attain high thermal efficiency. Operating performance has been consistently high. Humble's big fuel savings have more than made up for the slightly higher capital investment for air preheat equipment.

Finally, there was one other difficult design condition. The new heater would be required to operate for long periods without shutting down for maintenance or cleaning. The Lummus design included steam soot blowers which have kept both the bare tubes and studded tube in the convection section clean. The heater fires on heavy residual fuel oil having a very high solids content.

Lummus designs horizontal and vertical tube oil heaters to any size from 100,000 to 300,000,000 BTU/Hour for any process, anywhere in the world. Because Lummus offers *every* type of oil heater, you can be sure that we will recommend the *right* unit for your needs. Consult with Lummus on your next oil heater—large or small.

THE LUMMUS COMPANY, Oil Heater Division, 385 Madison Avenue, New York 17, New York, Houston, Washington, D. C., Montreal, London, Paris, The Hague, Madrid; Newark, N. J.



why UOP serves the petroleum industry so well

The fullest measure of service to the petroleum refining industry has been and will continue to be UOP's purpose. Starting with the research and design of petroleum refining and petrochemical processes, through the field and laboratory services performed in conjunction with these processes, UOP has directed its capacity to provide a wide variety of elements needed to aid the refiner in producing and marketing the best quality petroleum products.

Keeping refined products stable and maintaining product quality in transportation, storage, and use is an important area of UOP's aid to refiners. Over the years Universal has developed a wide range of petroleum inhibitors and additives to give refiners a reliable and economical means to safeguard the quality of their petroleum products.

Hundreds of refiners the world over are customers for UOP processes, services and products. Some use all . . . others use only certain specific processes, services or products. If you have a petroleum processing, marketing or product quality problem, talk it over first with UOP.

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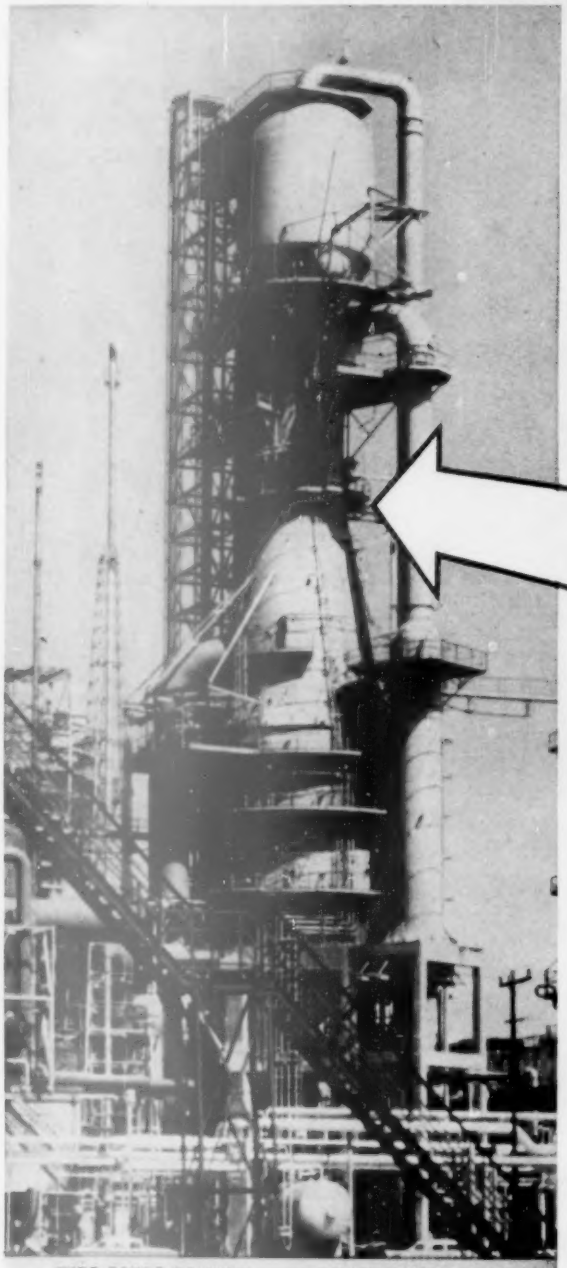

...You Get Dependable Operation with Jamesbury "Double-Seal"™ BALL VALVES*

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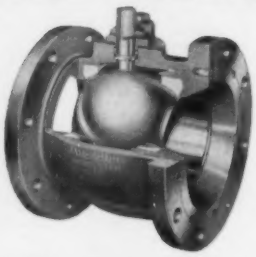

FIRE SAFE VALVING IN REFINERIES

The Jamesbury "Double-Seal" FIRE SAFE Ball Valve (Type DZ) has been accepted for use in the hydrocarbon industry because of its outstanding performance. In the event of fire — and the loss of the valve's soft seats, secondary metal seats provide effective shut-off of the fluid flow.

It stands to reason that a valve that performs outstandingly under adverse conditions can be relied on to give trouble-free performance under less severe conditions. That has been one of the big reasons, at least, for the success of Jamesbury "Double-Seal" Ball Valves. Proved dependable at *critical* valve control points, these valves have gone into industrial plants everywhere to control nearly all types of media flow.

There are many exclusive features about the Jamesbury "Double-Seal" Ball Valve which contribute to its excellent performance record. For example, there's Jamesbury's patented lip seal; there are no internal springs; you get leak-tight stem seals; operators are mounted integral with the valve. For further information about Jamesbury "Double-Seal" Ball Valves, contact your nearest stocking distributor — or write us direct.

WIDE RANGE OF SIZES:

Screwed end ⅛" through 3".

Flanged 150# series ½" through 12" — 300# ½" through 6".

Larger sizes on request.

VARIETY OF MATERIALS:

Valves in 303 and 316 Stainless Steel, Alloy 20, Carbon Steel, Bronze, Ductile Iron, Monel, Aluminum and PVC. Interchangeable seats and seals in Teflon, Teflon compounds, Nylon, Buna-N, Neoprene, Hypalon and natural rubbers. Type DZ: Ductile Iron and Carbon Steel, Standard.
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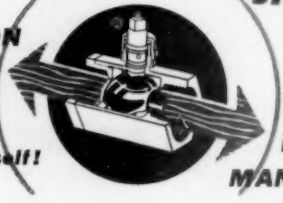

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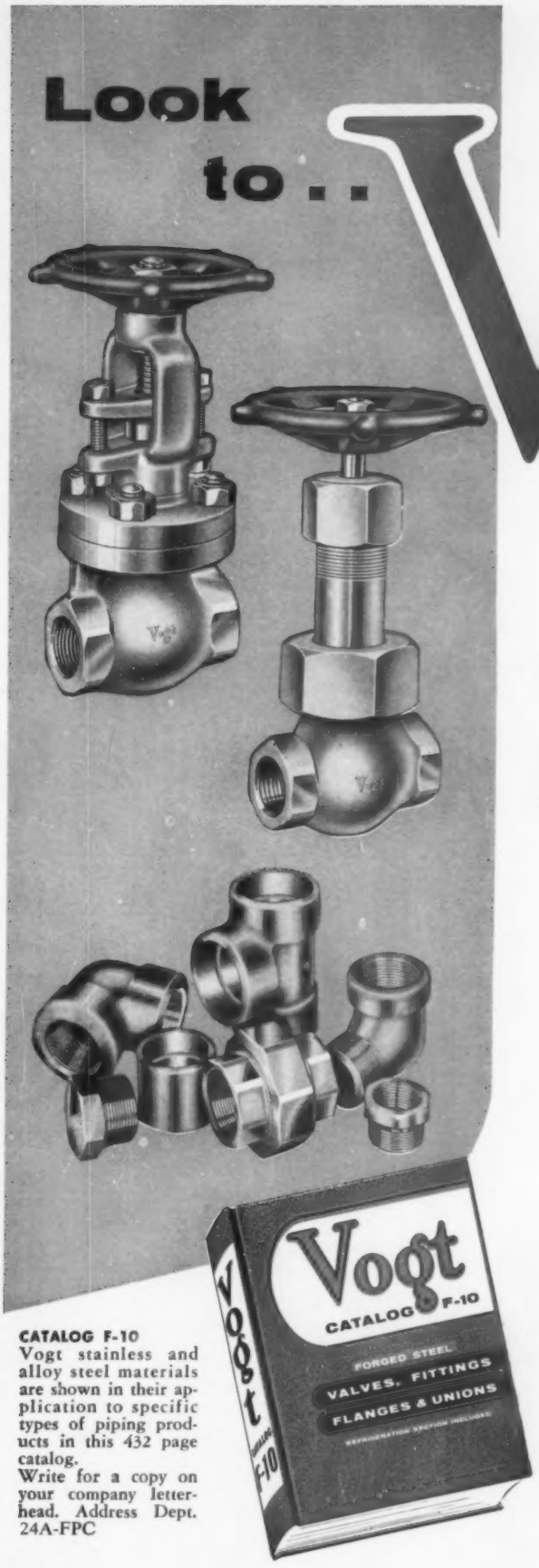

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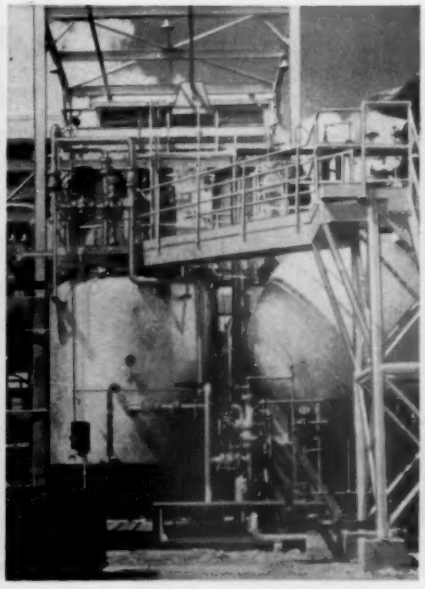
OHIO—Two of three two-stage ELECTROFINING Precipitators for treating kerosine, heavy cat gasoline, and light cat gasoline at Standard Oil Company of Ohio's Toledo refinery, which also utilizes a PETRECO Desalter.

CALIFORNIA—Richfield Oil Corporation, Long Beach, uses a PETRECO* Electric Desalter, a BENDER Catalytic Sweetening process, and four Petreco ELECTROFINING* Precipitators for gasoline, jet fuel, and kerosine treating.

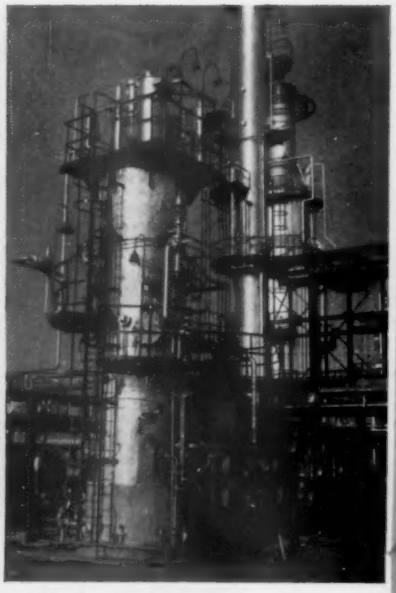
every day...all over the world...refiners are reducing treating costs with

PETRECO PROCESSING EQUIPMENT

CHILE—PETRECO* Electric Desalter in ENAP Con Con refinery.

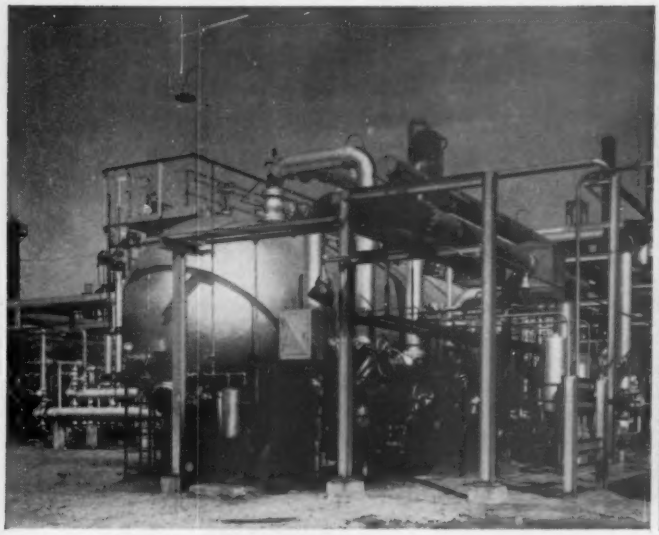


NETHERLANDS ANTILLES—Petreco ELECTROFINING Precipitator at a refinery in Aruba.



JAPAN—PETRECO Desalter and ELECTROFINING Precipitator installed in Kawasaki refinery of General Oil Company.

AR-61-1



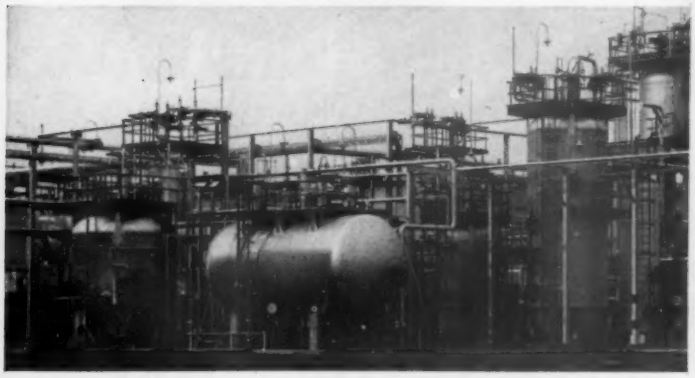
TEXAS—Two-stage PETRECO Desalter in Sunray refinery at Shamrock, Texas.

DELAWARE—PETRECO Desalters on huge Tidewater Association crude unit at Delaware City refinery.

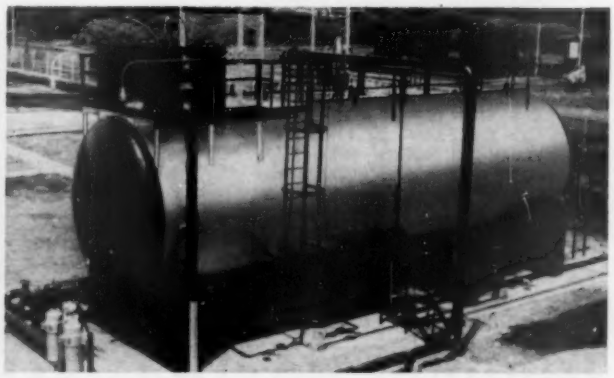
Petreco performance around the world tells a money-making treatment story, easily understood in any language. The Petreco installations shown here suggest how global this understanding is. It grows with every new application, and amplifies itself day after day in the hundreds of Petreco electric precipitation units now in use.

If you don't have this modern treating equipment for impurities removal, sweetening, color specification, stability, "scrubbing" or water-washing, write for complete information on the efficiency and economy of Petreco processing equipment.

*Registered trademark, Petrolite Corporation



ENGLAND—Esso refinery at Milfordhaven includes PETRECO Desalter, and three Petreco ELECTROFINING Precipitators for distillate treating.



VENEZUELA—Shell Oil Company's PETRECO Desalter at the Tia Juana installation.

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Integral Bonnet "Y" Valve—Figures 1314A (1500PSI), 25014A (2500PSI) — for high pressure steam, boiler feed water, bypass, instrument and throttling services. Furnished in steel and stainless steel with socket welding ends. Globe and angle valves also available.

Bronze Gate Valve for 200 psi—Fig. 375. Union bonnet, inside screw rising stem, interchangeable solid or split wedge, integral seats. Available with flanged ends.

Iron Body Bronze Trimmed Gate Valve for 125 psi—Fig. 1793. Bolted yoke-bonnet, outside screw rising stem, solid wedge, bronze seats. Available with screwed ends and in all iron.

Stainless Steel Gate Valve for 150 psi—Figs. 2453SG (Solid Wedge), 2453DG (Split Wedge). Bolted yoke-bonnet, outside screw rising stem, integral seats. Wedges are fully guided.

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When you buy Powell, you buy dependable performance—the result of engineering skill, and experience. For further information, call your Powell Valve Distributor or write direct.

Iron Body Bronze Trimmed Swing Check Valve for 125 psi — Fig. 559. Bolted flanged cap, renewable bronze seat and disc. Screwed end and all iron valves are available.

Steel Gate Valve for 300 psi — Fig. 3003. Bolted yoke-bonnet, outside screw rising stem, solid wedge, screwed-in seat rings. End flanges have 1/16" raised face. Screwed end and welding ends can be furnished.

ASA 150-pound Carbon Steel Lubricated Plug Valve — Fig. 1563G. Bolted gland type, worm gear operated. Spur gearing can be furnished. Facing, drilling and dimensions conform to latest standards.

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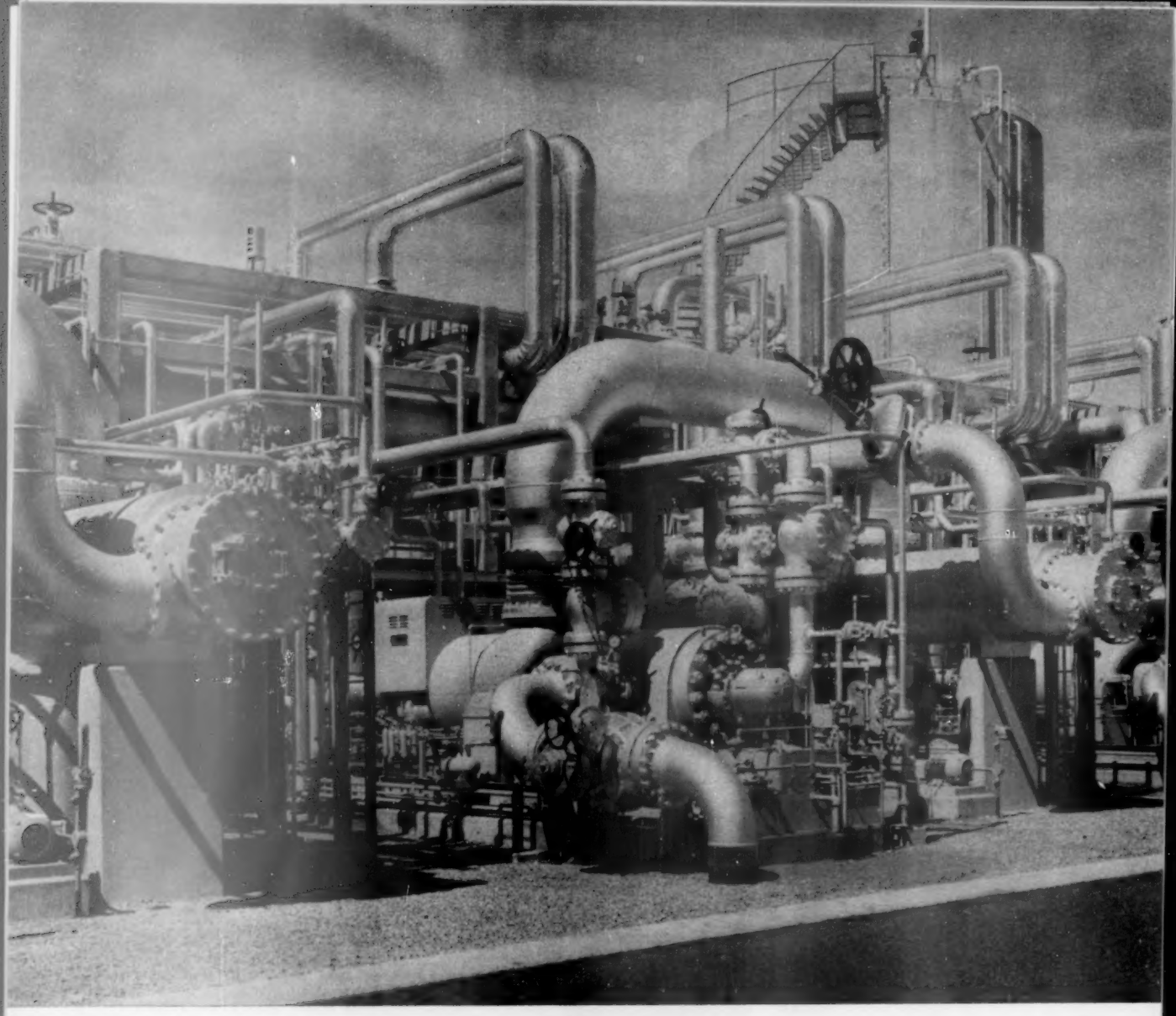
THE WM. POWELL COMPANY CINCINNATI 22, OHIO

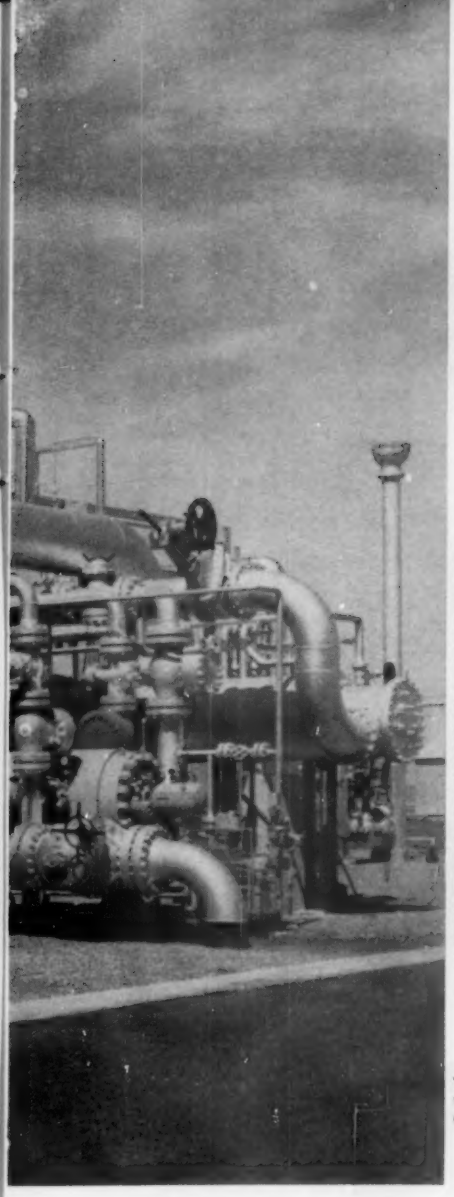


AT HUMBLE'S KING RANCH GAS

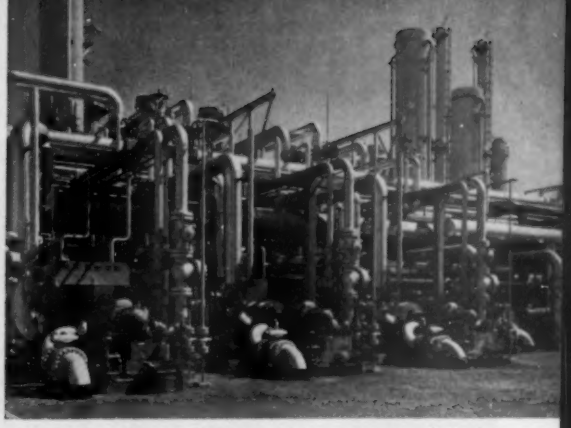
These pumps have a combined capacity of 139,000 gpm —

This new plant also contains five Ingersoll-Rand air compressors and two Ingersoll-Rand steam-jet ejectors for vacuum service.

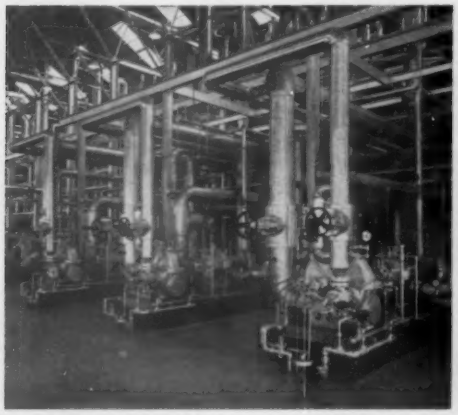
Whatever *you* need in the process-pump line is available from Ingersoll-Rand, manufacturer of the world's ***most complete line*** of centrifugal pumps.



Five Ingersoll-Rand VHTB multi-stage vertical pumps for handling propane and butane at shipping terminal for distribution to product pipelines.



Three Ingersoll-Rand HMTA four-stage pumps specially designed with one interstage bleed-off connection to combine two lean absorption oil services for pressure levels of 480 and 1000 psig.



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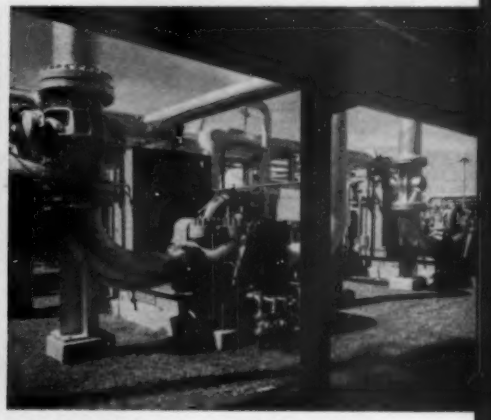

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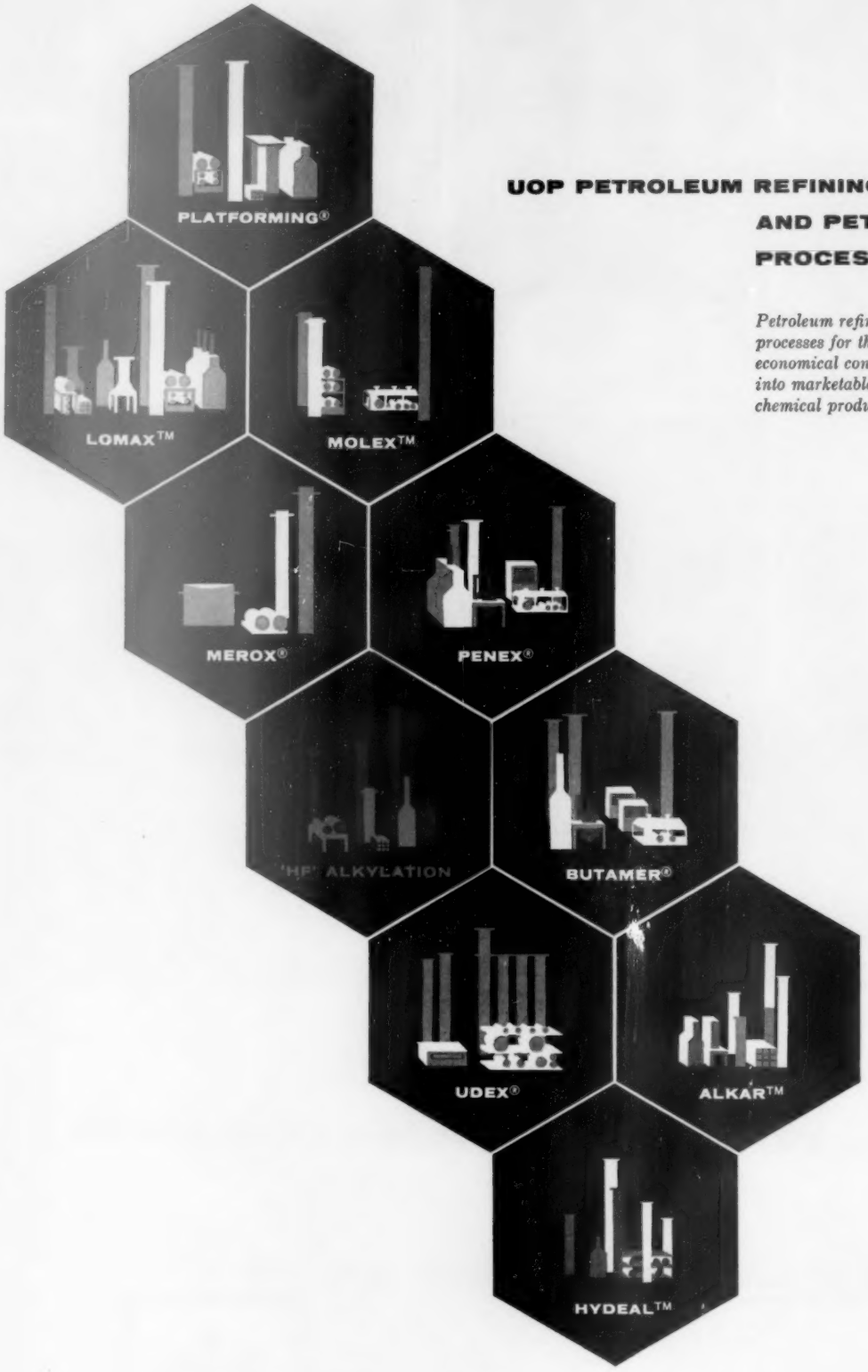

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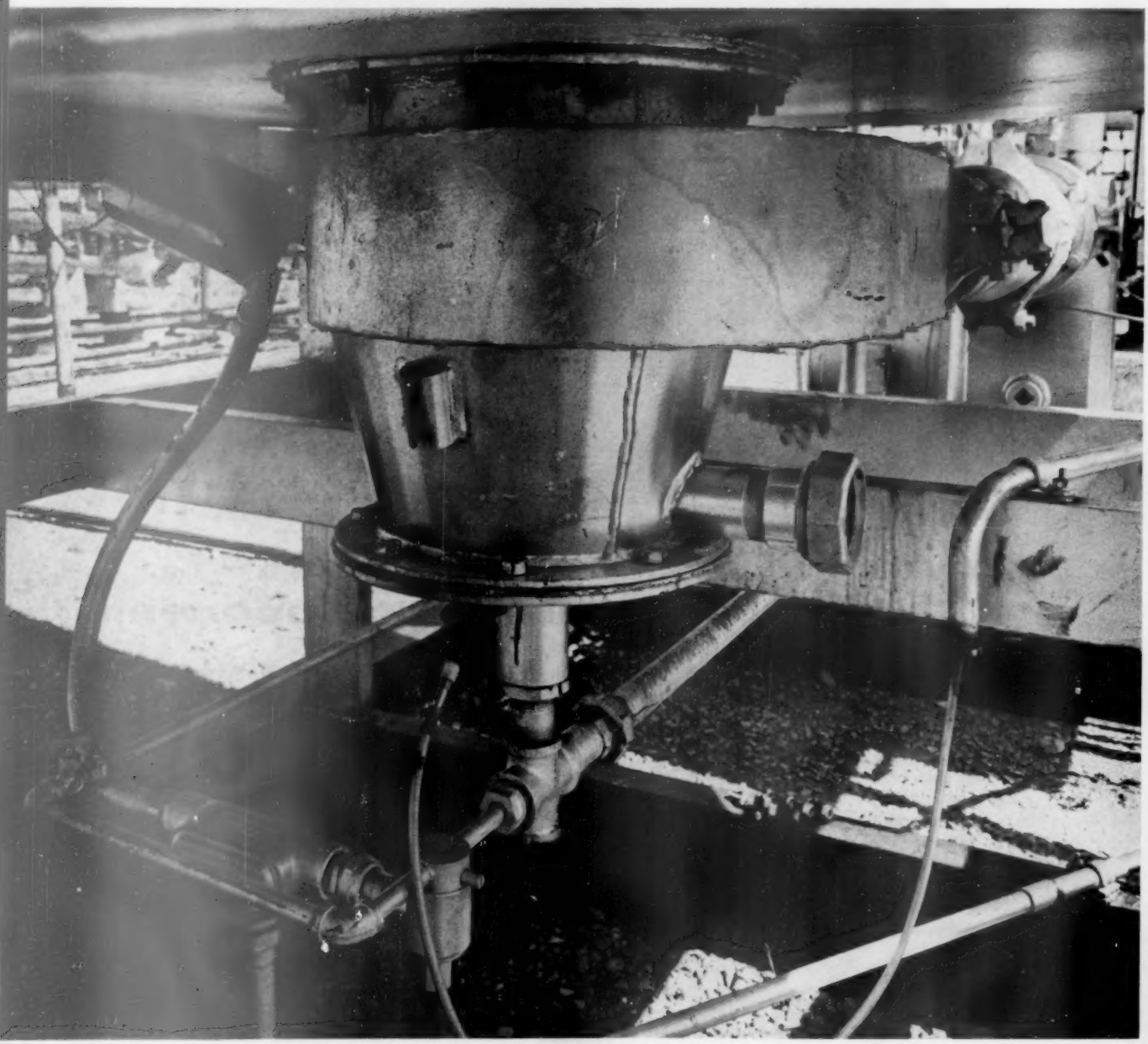


Fig. 1. Reactor unit used with new design of heat exchanger.

Convective Transfer

by John Thurley

A NEW TYPE of fired heater that employs convective rather than radiant heat transfer promises to have wide application in HPI for general heating duty.

The combustion reaction takes place in a separate chamber or "fuel reactor," and the hot gases are discharged to a heat exchange section where transfer is predominantly convective.

Rapid recirculation of flue gases is caused by jet velocities of the hot combustion gases. This results in uniform heat absorption around the circumference of the tubes, with accurately predictable skin temperatures. Fig. 2 illustrates the fuel reactor-fired heating method.

Test data from a 3,000,000 Btu/hr experimental unit is given in this article, together with a discussion of the combustion and heat transfer mechanisms underlying its operation. Sufficient information is given to enable comparison with conventional radiant-type heaters.

Key Features

The fuel reactor features almost instantaneous heating from ambient to 3000 F. The process fluid can be brought up to operating temperature in a few minutes from a cold startup.

Since the combustion reaction is completed before discharge of hot gases into the heat exchanger, the combustion rate is not slowed as a result of heat transfer lowering the temperature of the reacting gases. A smaller combustion volume is required.

Another benefit is the reactor's ability to burn with nearly zero percent excess air, producing zero percent combustibles with no flame extension out of the unit.

High heat release units are now available with combustion heat release rates of 10,000,000 Btu/hr/cu ft of combustion volume and above.

Fraser[2] classifies them as two types: thermal jet burners, where the design emphasis is on obtaining high jet velocity, and high combustion chambers, where emphasis is on composition of the gaseous products of combustion. He describes one apparatus designed for high jet discharge which, from a combustion chamber pressure of 2½ psig, can produce a gas velocity of about 1400 cu ft/sec.

Francis and Jackson[1] have made available essential information for the design of jet burners using air blast injection, with particular reference to high pressure efficiency to obtain maximum discharge velocity.

Problems with fuel reactors in the past have been mostly concerned with refractory maintenance, due to the high temperature of the reacting gases. However, recent designs have eliminated the need for refractory with all-metal construction cooled by incoming combustion air.

Operating Principles

The fuel reactor described here is of the vortex type is illustrated in Fig. 1 and 3. This particular unit requires combustion air at a minimum pressure of 3 in. water column and will operate at any higher pressure. The fuel gas can be supplied at any available pressure from 1 in. wc to 50 psig. The heat release at 20 in. wc combustion air pressure is 10,000,000 Btu/hr/cu ft of combustion volume.*

The reactor consists of a double-walled combustion chamber composed of an outer shell and a coaxial internal liner shown in Fig. 3. The combustion air enters the annular space through a tangential inlet at the front of the reactor. It then follows a helical path toward the rear end of the outer shell and there mixes with the fuel, which is injected into the rear of the reactor. The smaller cross-sectional area at the rear of the shell encourages the conversion of pressure energy in the combustion air into rotational kinetic energy before mixing with the fuel.

*Compared with 6000 Btu/hr/cu ft for a refinery Platformer heater tested by Thorneycroft and Thring.[7]

In the operation of such a reactor, this fast rotation of combustion air causes extreme turbulence at the small diameter rear end of the chamber where the fuel is introduced. The air rapidly mixes with the fuel and high intensity combustion takes place in this region which is the primary combustion zone.

The helical flow of combustion air causes it to sweep over and cool the rear end of the shell by enclosing the primary combustion zone.

The products of combustion in the primary combustion zone, together with any unburned fuel and excess combustion air, flow forward through the liner which thus constitutes a secondary combustion zone in which combustion is substantially completed.

The combustion air flowing in the annular space between the liner and the outer shell cools both of these components, while the stainless steel liner acts as a shield for the outer shell against radiation from the secondary combustion zone.

The internal liner is shaped divergingly toward the combustion outlet so that the helical flow of air creates a vortex which causes recirculation of the reacting gases.

The products of combustion, burning combustibles and air all flow in a helical path along the periphery of the liner toward the reactor outlet. These gases are then recirculated in the reverse direction back down the center of the vortex. Between these flow zones is a layer which remains stationary because the faster these gases flow through the fuel reactor, the faster the recirculation gases are pulled back by the vortex. This gaseous layer is composed of eddies created by two gaseous streams flowing over each other, the direction of flow of the two streams being approximately opposite.

Flame-Out Impossible

The eddies formed act as a flame holder for the combustion reactants, and the flame cannot be blown out of the reactor even when the velocity of the combustion mixture through the reactor is many times the velocity of flame propagation. On a conventional burner, flame-out results when the velocity of gases through the burner exceeds the flame velocity, thus preventing the flame from burning through the combustible mixture back to the burner.

Combustion rates in excess of 10,000,000 Btu/hr/cu ft (combustion air pressure drop of 20 in. wc) are possible due to the fuel reactor's unique flame holding characteristic. However, for standard applications the higher combustion air pressure drop required would not be economical.

The fuel reactor is capable of using low pressure gas since fuel is injected into the low pressure core of the vortex. Alternatively, high pressure gas can be used with equally good results. There is no premixing with air — an advantage when burning hydrogen or other fuels with high propagation rates, where flash-back might occur.

Flame stability is achieved at low gas turndown even with high flow rates of combustion air. The excess air flowing in a helical path along the periphery of the reactor liner produces a zone of low turbulence at the center of the reactor where the fuel is injected. This enables very high fuel gas turndowns and also fuel air ratios from 50% stoichiometric to 100 times the theoretical air requirement, without loss of flame.

The fuel burned in the reactor is raw gas with no premixing with air. This is of benefit when burning hydrogen and other fuels with high rates of flame propagation. With a raw gas burner flash back cannot occur.

No refractory is required in the fuel reactor even with outlet gas temperatures of 3000 F. The internal liner acts as a heat exchange surface; the incoming combustion air is preheated and in turn cools the liner to a safe operating temperature. The complete absence of refractor enables the unit to reach operating temperature in one or two minutes from a cold start. The low heat storage in the reactor gives it an excellent response to load changes.

Experimental Equipment

The important variable functions controlling rate and uniformity of heat transfer to the tube surface are:

Tube location and spacing
Size of inspirating muffle
Velocity of jet discharge from the inlet orifice
Temperature of jet discharge
Average flue gas temperature
Tube wall temperature
Percentage of excess air

For the initial development a water table was used to obtain the best orientation of tubes for uniform distribution of heat around the tubes. The water discharge velocity from the inlet orifice and the muffle spacing was checked by dynamical similarity to obtain the equivalent flows for discharging high velocity combustion gases into a heat exchanger.

The water table consisted of a plastic-lined steel plate with a transparent plastic cover mounted so as to contain magnetic tubes and

walls in a 1-in. space. Any configuration of tubes and walls could then be quickly made up and checked after clamping the assembly to the water table.

Injection of small bubbles of air into the inlet water jet was found to give an excellent indication of recirculation velocities, and this was further improved by the use of a small amount of detergent as a wetting agent. Dye injection was unsatisfactory, due to rapid mixing.

Next, a three-dimensional model was built and hot air was discharged at high velocity from inlet slots into muffles mounted on the base of the heat exchanger. The tubes of the heat exchanger contained wax, and it was possible to observe uniformity of heat transfer by the melting of wax in the different tubes. The experiments with this model suggested extreme uniformity of heat distribution.

A 3,000,000-Btu/hr experimental unit was built for test purposes. The heat exchanger is shown diagrammatically in Fig. 4, and consists of a central section, heated by jet-recirculated flue gas, and two outer waste heat recovery sections. The hot products of combustion were discharged at high velocity from three fuel reactors mounted 2 in. apart on the floor of the heat exchanger cabin. The flue gas was discharged from the bottom of the inner chamber through two heat recovery sections to stack.

The center section consisted of two coils of 4-in. diam pipe located on each wall. Distance between each horizontal tube was three diameters and distance between each coil was 1.5 ft between centers. Space between each coil and cabin wall was 4 in. Height from floor of the heat exchanger to the roof was 7 ft.

Natural gas was circulated through coils of the unit in a closed loop system and externally cooled by water in a heat exchanger. It was possible to vary the quantity of gas flowing through the tubes over a wide range of flows and pressure, and therefore for a given heat absorption adjust the tube wall temperatures to any required figure by alteration of inside film coefficient of heat transfer.

During the tests the process fluid was allowed to enter at the bottom and top of the two coils so that the tube metal skin temperature and heat absorption rates could be checked with the process fluid flowing co-current and countercurrent to the direction of the inlet combustion gases.

Thermocouples were attached to points around the circumferences of the tubes. These were located at points on the tube lengths exactly opposite the discharge jets from two

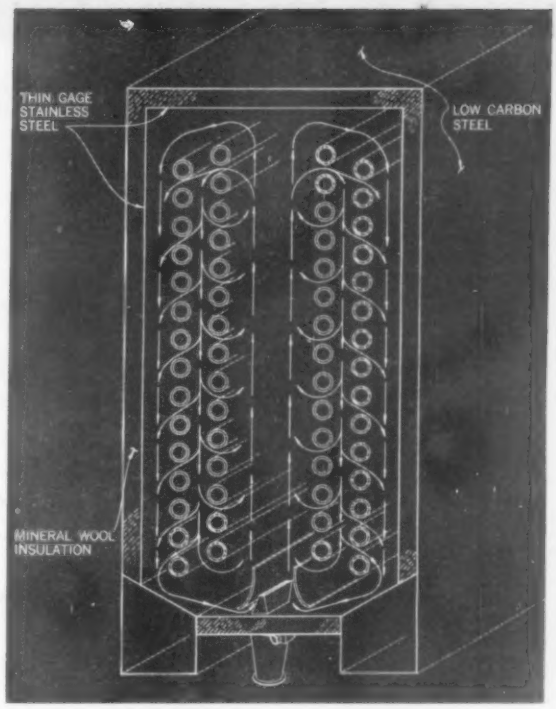


Fig. 2. Fuel reactor-fired heat exchanger.

of the fuel reactors and also at points equidistant between the two fuel reactors.

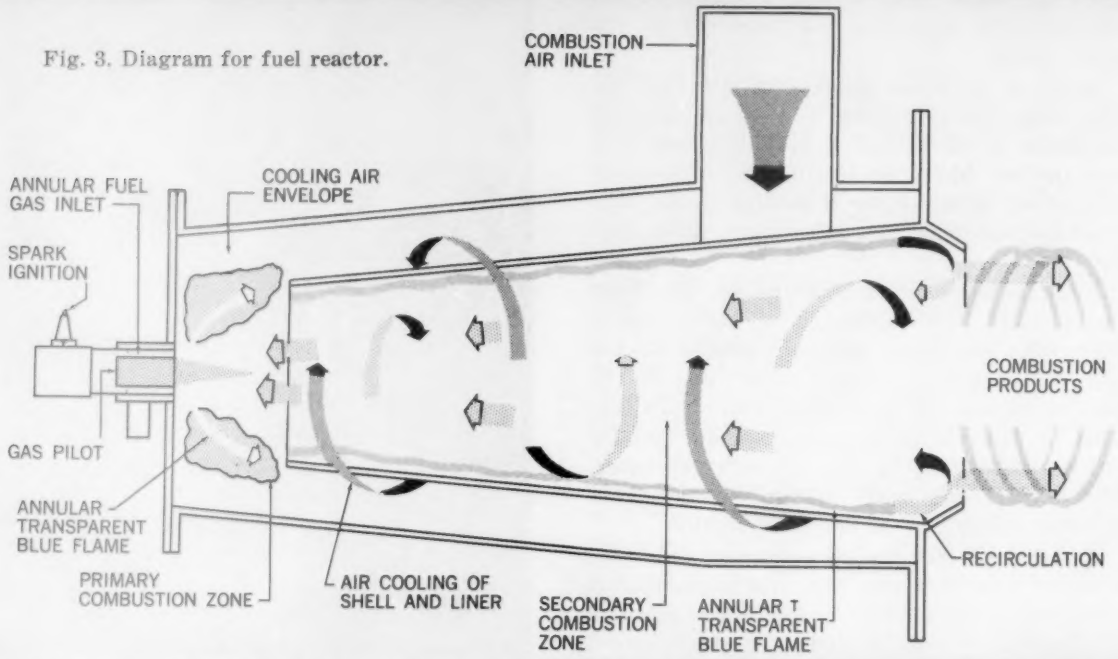
A total of 77 thermocouples were located on the coils and muffles of the heat exchanger. In addition, flue gas temperatures were measured by probes at points in front and behind each tube and along their length. Temperatures were also taken of the roof and cabin of the heat exchanger for each test run, to ascertain the correct materials of construction. Probes inserted along the inside of process tubes indicated the fluid temperature opposite tube wall temperature points.

The quantity of process gas flowing and the inlet and outlet process temperatures of the coils were measured to obtain the heat absorbed. The combustion air and fuel gas flows were measured and the heat release calculated conventionally. The stack gases were continuously analyzed for oxygen and combustible content.

Again, the purpose of these tests was to obtain rates of heat transfer between the flue gas and the heat absorbing surface of the tube wall. The temperature of both the flue gas and heat absorbing surface were altered for each test run. The uniformity of heat absorption around each tube circumference was also checked, and the percentage of convective heat transfer to radiant heat transfer for different flue gas temperatures was obtained.

Of the variables listed, these were kept con-

Fig. 3. Diagram for fuel reactor.



stant during the tests: temperature of jet discharge from inlet orifices (by keeping excess air at approximately zero), tube spacing and distance of the coils from the wall and the muffle spacing. Size of the inlet orifice was kept constant so that velocity of jet discharge was proportional to heat release.

Experimental Results

Results from the test heat exchanger are shown in Table 1. In calculating the radiant heat transfer contribution, the following modification of the Stefan-Boltzmann law[5] was used:

$$\frac{Q}{A} = E_s[(q_{CO_2} + q_{H_2O})_{T_g} - (q_{CO_2} + q_{H_2O})_{T_s}]\frac{100 - \%}{100}$$

where Q = radiant heat transferred, Btu/hr
A = tube circumferential area, sq ft
E_s = emissivity of the tube wall
q = radiant flux of CO_2 and H_2O at gas temperature T_g (R) and tube wall temperature T_s (R), Btu/hr/sq ft
% = interference correction

The development of this equation is given in Kern[5]. Values of q and % were obtained from graphs in the same reference. It was assumed that since the tubes were surrounded by recirculating gases, no angle factor was required. It was also assumed that there was no radiant transfer from the walls of the exchanger, since their temperature was relatively low.

This series of tests was concerned with obtaining heat transfer data for heating to process outlet temperatures of 650 F with recirculated flue gas temperatures of the order of 1000 F. The fuel reactor was designed to operate with a simple single-stage centrifugal blower. The discharge velocities obtained by the energy conversion of the fuel in the reactor were of the order of between 100 and 500 ft/sec.

Fig. 4 illustrates the uniformity of gas temperature around the tubes under the worst case, with zero percent excess air and reactor exhaust temperature above 3000 F.

The big difference in temperature of the two blending gases gives an indication of the large volume of gas recirculated around the tubes to obtain this uniformity. The possible gas velocities of 1400 ft/sec referred to earlier, would of course, improve the uniformity, but differences here of 900 F to 1150 F in flue gas temperature compared favorably with a 2500 F flame on the front side of the tube and 1000 F gas on the back side of the tube in a conventional process heater.

Discussion of Results

The results show convective heat transfer coefficients of between 15 and 30 Btu/hr/sq ft /F, compared with the assumed value of 2.0

TABLE 1. Results From Test Heat Exchanger

Test No.	Net heat release MMBtu/hr	Average flue gas temperature F	Average tube wall temperature F	Flue gas analysis		Heat transferred to tube outside surface					The convection coefficient between flue gas & tube wall Btu/hr/sq ft/F
							Radiant		Convective		
				% oxygen	% combustibles	Total Btu/hr/sq ft	Btu/hr/sq ft	Percentage of total	Btu/hr/sq ft	Percentage of total	
1	1.86	1128	424	0.30	0.00	12,150	2,000	16.4	10,150	83.6	14.4
2	1.88	1140	496	0.25	0.00	11,150	1,920	17.2	9,230	82.8	14.3
3	2.11	1207	622	0.20	0.10	12,800	2,110	16.5	10,690	83.5	18.4
4	2.43	1290	617	0.25	0.05	14,520	2,620	18.0	11,930	82.0	17.6
5	2.79	1287	676	0.30	0.05	16,210	2,510	15.4	13,700	84.6	22.4
6	2.82	1297	624	0.20	0.00	17,100	2,610	15.3	14,490	84.7	21.5
7	2.84	1306	637	0.05	0.05	16,900	2,710	16.0	14,190	84.0	21.2
8	2.93	1294	664	0.25	0.00	17,600	2,680	15.2	14,920	84.8	23.6
9	2.96	1320	663	0.15	0.00	17,950	2,760	15.4	15,190	84.6	23.2
10	2.99	1352	579	0.55	0.00	18,050	3,140	17.3	14,910	82.7	19.3
11	3.01	1393	685	0.38	0.02	18,250	3,280	17.9	14,970	82.1	21.2
12	3.66	1418	785	0.30	0.00	17,450	3,270	18.7	14,180	81.3	22.4
13	3.69	1391	733	0.30	0.20	21,600	3,260	15.1	18,340	84.9	27.9
14	3.81	1394	833	0.15	0.03	20,700	2,920	14.1	17,780	85.9	31.6
15	3.82	1420	835	0.10	0.00	21,300	3,110	14.6	18,190	85.4	31.1
16	3.89	1413	808	0.20	0.00	20,000	3,230	16.1	16,770	83.9	27.6
17	4.33	1456	717	0.35	0.00	25,300	3,620	14.3	21,680	85.7	29.4

Btu/hr/sq ft /F used in radiant heaters.[3] This explains why, for the heater temperature ranges tested, the percentage of convective heat transfer in the test heater was as high as 86% of the total heat transferred. For similar tube wall and flue gas temperatures, the total heat transferred in the exchanger is approximately twice that obtained in a conventional heater.

Circulation of flue gases around the tubes improved the uniformity of heat absorption over the whole tube circumferential area.

Test 7 was selected for comparison purposes with the data published on heat absorption by Mathis, Schweppe and Wimpress[4]. They used a tube wall temperature of 900 F and a flue gas temperature of 1450 F, and Test 7 was set to be nearest to these figures.

It was observed in the test heat exchanger that the inspirating effect of the jet in the muffle further improved this uniformity of heating, by replacing the natural circulation of gases around the tubes with fast forced circulation of flue gases.

In the experiments 4-in. pipe was used in both the heater and heat exchanger, but close comparison is not possible due to difference in tube spacing.

Test results of stack gases from the sum of three fuel reactors showed possible operation at near zero percent excess air. The minimum figure with zero percent combustibles was 0.1%, and all results were below 0.55% excess oxygen. This increases efficiency and reduces oxidation of the tube surface.

There was no flame extension into the heat exchanger. It was observed by temperature probes that the gases recirculating around the tubes were at relatively low temperatures compared to the high temperature jet, due to the tempering effect in the muffle of the cooled recirculating flue gas.

The sensible heat of gases from completely burned fuel can be reduced more quickly than that of flames with high temperatures maintained by a continuous supply of heat energy.

Due to the completely sealed nature of the fuel reactor and the heat exchanger, the unit was observed to have a lower noise level than conventional premix gas burners.

The fuel reactor and heat exchanger outer surfaces were observed to remain cool. The sealed nature of the equipment and internal spark ignition were other safety features.

The convective heat transfer method of heating enabled the process outlet temperature to be obtained in minutes. This was further aided by the absence of heavy refractory material in the heater cabin. The small heat storage also prevented the tubes from being overheated after the process flow and fuel gas supply were shut

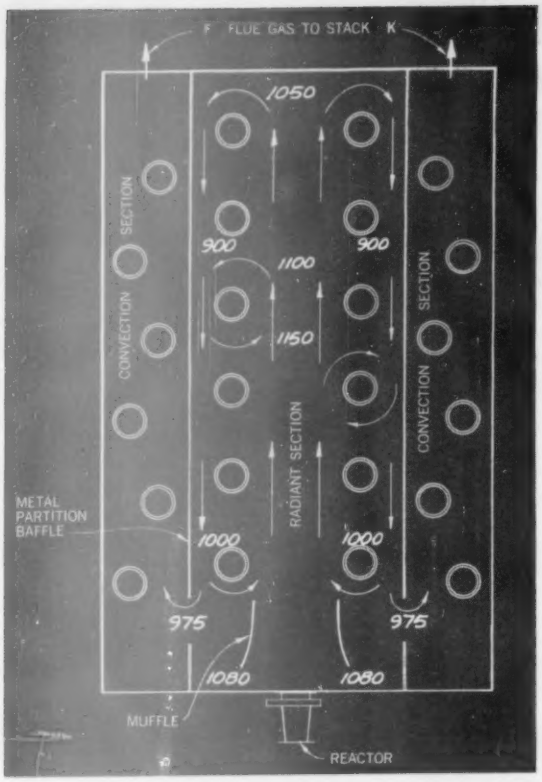


Fig. 4. Diagram of reactor-fired exchanger built for test purposes, and illustrating uniformity of gas temperature around tubes.

off. Quicker cooling could be effected by allowing the combustion air blower to continue operation and circulate cold air around the tubes.

Faster response was obtained by the use of finned tubes. These were found to operate satisfactorily due to the uniform heat absorption obtained by the convective heating. With fins, heat transfer was greater than 90% convective.

The lower stack temperatures due to higher convective coefficients and to nearly zero percent excess air make possible net thermal efficiencies as high as 80% without a heat recovery section and as high as 90% with such a section.

Tests showed that for a given heat absorption rate and process temperature it was possible to predict accurately the maximum metal skin temperature.

The test heater could be skid mounted, and due to its lightness did not require foundations.

The combustion release of 10,000,000 Btu/hr/cu ft and the replacement of a large furnace volume by a compact heat exchanger suggested the design might permit packaging up to 100,000,000 Btu/hr absorption.

Absence of refractory heat storage in the heater walls prevented a temperature time lag when process flow rate was altered. This permitted a closer control on heater outlet temperature.

Advantages Cited

The convective method of heating appears to have these advantages:

1. Absence of flame impingement
2. Uniformity of heat absorption
3. High efficiency
4. Lightness
5. Low noise level
6. Safety in hazardous areas
7. Suitability for intermittent operation when a non-refractory heat exchanger cabin wall construction is used
8. Fast response of heater outlet temperature control
9. Sealed unit, preventing air infiltration or flue gas leakage out
10. Compactness
11. High average heat absorption rates
12. Low process coil pressure drop

All of these advantages may not be significant when making specific comparisons with conventional radiant units. Also, the additional power requirement of the combustion air blower must be considered.

The author has found that for many applications the fuel reactor-fired exchanger offers distinct overall advantages over conventional units.

About the Author

John Thurley, now with Black, Sivalls & Bryson, Inc., Oklahoma City, was director and general manager of Gibbons Heaters, Ltd., London, England, from 1957 to 1960 when he made patent applications on the fuel reactor-fired heating unit. He joined BS&B in 1960 when the patent rights and development work were transferred to that company from Gibbons. Thurley, who holds a BS in Chemical Engineering from London University, served as a process engineer and combustion engineer with Mobil Oil Co., Ltd., at the Coryton, England, refinery before going with Gibbons.

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by Louis R. Bechtel

Evaluating Joint Ventures

What can companies gain by entering into joint ventures?

A joint venture can balance strengths and deficiencies of the partners, i. e., manufacturing know-how and marketing outlets. It offers a good opportunity for aggregating capital investments. The partnership is easy and inexpensive to organize. Research costs are reduced, since duplicated efforts are avoided.

On the debit side, the organization can be unwieldy, there can be disagreement where each partner has the same authority, and the need for continuous harmony can become strenuous.

Here are types of joint ventures with greatest application to the Hydrocarbon Processing Industry, possible alternatives, contingent pitfalls and steps in establishment of a joint venture.

Types of Joint Ventures

Quite often a by-product material from one company's existing routine process provides a suitable feed which in combination with a second material can produce a third valuable product. Thus, one company may have by-product carbon dioxide from a partial oxidizer which has been justified on the basis of a need for hydrogen. On the other hand a second company has incremental ammonia capacity available. The production of urea from carbon dioxide and ammonia provides for a natural joint venture. The venture upgrades a by-product of one member and fills out idle incremental capacity of his partner.

It is a basic premise of evaluations that a unit twice as big as another unit does not necessarily cost twice as much. Various power factors are used relative to the scaling up of inside battery and offsite equipment but, in general, the six-tenths power best described the overall advantage of size. In other words, doubling the size of a unit increases the investment by a factor of about one and one-half.

As an additional feature, the absolute fixed costs of operation, i. e., labor, repairs and overhead, remain somewhat independent of plant size. Thus the larger the volume of product, the cheaper the unit cost of that product.

It is these two concepts, the dollar advantage of investment through size and the advantage of reduced unit fixed costs, that encourage companies with common feeds and common products to join forces.

The current interest in aromatics extraction and hydro-dealkylation units serves our example here. Catalytic reformates of oil companies are excellent sources of aromatics. To gain the benefits of size described above, the main concern is that the interested companies be advantageously located to avoid excessive transportation costs or investment in conjunction with the aromatics processing unit.

We are in an economic era of integration. The profit squeeze between stages of raw material processing and the marketable commodity brought about through keen competition makes it necessary for the manufacturer to upgrade his basic feed to as near the ultimate product value as is practical. Therefore, the tendency to join the producers of chemical or petroleum intermediates and the final product provides for

a natural and profitable marriage. Both partners can benefit from long term volumes of supply and demand coupled with the inherent cost advantage.

In a sense, such joint ventures are actually combining primary manufacturing know-how with marketing know-how. The ability has provided several petroleum companies with a key with which to open the door of chemical sales. Ethylene to polyethylene, propylene to polypropylene, benzene to styrene to polystyrene and acetylene/ethylene to vinyl chloride to polyvinyl chloride all illustrate the attractiveness of joint ventures relative to a crude oil source and a polymer market. The profit chain in moving from crude oil through intermediates to finished petrochemicals is well served through joint ventures.

Alternatives to Joint Ventures

The economic analysis of going the project alone must always be evaluated. This serves two functions. It provides a normal evaluation and cost estimate which can be measured against the profitability yardstick of the company. The limitations to the project are also brought out at this time. Perhaps the feeds available are inadequate or too costly. Or the capital requirement is too high. The hazards of marketing a new commodity could be a deterrent. The ratio of fixed costs to product volume must be studied. All the economic pitfalls of analysis are brought out in this initial internal study.

The second function in evaluating the sole company project is that a firm basis is established for comparing these results with the attractiveness of the joint venture. A direct comparison of capital requirements, operating costs, material costs and rates of return between the joint and individual venture can be made. With this basis the area for judgment has been narrowed and the decision can be met — to join or not to join.

Quite frequently the economic climate is such that capacity of chemical production exceeds the demand. Equipment becomes available for leasing or rental. Use of this equipment as a part of the planned project could save capital costs and influence the profit picture. This approach requires careful scrutiny and negotiation since the lender must be adequately compensated for his trouble. Such associations are normally of short duration and rarely does this situation lend itself to the type of project considered in joint ventures. It is, however, an alternative.

Other Points to Consider

Progressive firms plan ahead. And in planning ahead new products are being developed and existing products expanded. Does the joint venture partner compete in areas which are on your own horizon? Will this joint venture deprive the company of a preferred future feed for another purpose or does the process conflict with future plans? A company's future plans for its raw materials and products are fringe items which might add to or detract from the attractiveness of the joint venture.

It is important that the management philosophies of the joint venture policy makers coincide at least to some reasonable extent. The magnetic principle that opposites attract should not necessarily be followed in selecting partners for joint ventures. There is a multitude of areas where agreement must be met based on the company's individual outlooks. Mutual decisions regarding plant battery limits, selection of equipment vendors, construction codes, prorates of costs, necessary exchange of confidential information, areas of responsibilities for design and scheduling, acceptable analytical methods, etc., all reflect the philosophies of the joint venture managers.

Effecting a Joint Venture

How does a typical joint venture come about? Once the reasons for the joint venture are established, a bonafide interest should be developed. Top-level managers define the scope of the project and the relationship of each partner—all on a preliminary and quite general basis. A timetable for the economic evaluation and cost estimation is established.

Let us assume that the companies are interested in joining for the benefit of size. Both companies will feed a common material. The production will be shared, but the products marketed individually.

Following the initial contact, each partner prepares preliminary flows, cost estimates and investments. Each partner should satisfy himself whether or not the joint venture presents the best opportunity for profit when compared with alternatives.

The basis for the individual evaluations is reviewed. Utility rates and requirements are compared. These rates may be considered on either a total cost or incremental cost basis, dependent on plant location and the available facilities. Operating costs of the joint venture are what demand most attention and agreement. Since each partner justifies his own interest indepen-

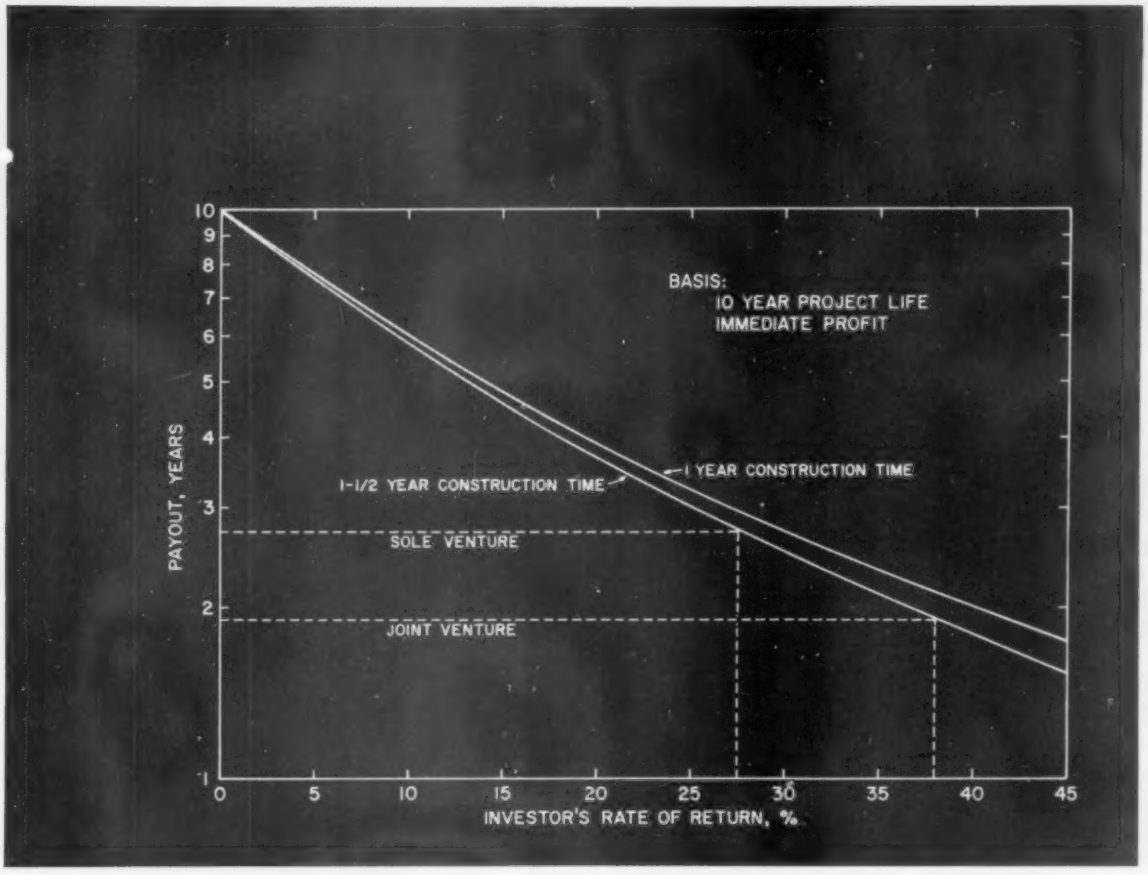

Fig. 1.

dently, with common feeds the material values and product realizations of one partner are of no consequence to the other unless materials are interchanged. The assigned values of feeds and the netbacks (selling price less marketing and freight costs) of products are influenced to a considerable extent by the transportation costs and the locations of markets.

The location chosen for the joint venture is important since it sets the transportation debit of moving feeds to the processing unit and products to market. The many factors which dictate location of the joint venture are not essentially different from those which determine location of any new plant except for the necessary mutual agreement of the partners. Availability of real estate at one partner's existing units might be an influence. The physical characteristics of feeds force the location to be an "over the fence" operation. Better utilities available at one of the partner's plants could be a deciding factor.

At this time the joint venture interest seems genuine. With ground rules agreed upon, a timetable is established for receiving bids, reviewing these bids and selecting the successful contractor. Again, the essential difference between the sole company venture and the joint venture in this area is one of the necessary agreements. It may be advisable to get process design and investments on both an individual plant and the joint plant. This would provide for a more sound evaluation of the alternate of going it alone. Once the contractor is selected, areas of responsibility are defined to expedite the project. Coordination of efforts becomes a prime concern.

Methods for prorating the costs are exchanged and decided upon. It is the exception more than the rule that feed and product volumes and qualities are precisely the same. Therefore, it behooves the partners to satisfy themselves that the accepted prorates are equitable. Perhaps the operating costs of certain units of the plant are more suitably proportioned on feed while others are more fairly distributed on product ratios. However, it is important to realize that the limit of details behind any cost proration is partly dependent on the maze of bookkeeping which could develop. In other words, the advantages to be gained in the metering and accounting of minute details could well be offset by additional clerical dollars. Finally, the accepted formulas for cost

proration should be reviewed after a specified interval of plant operation to point out any inequities.

Illustration

To illustrate what can be gained by the successful culmination of what has been described, assume that Company A can sell 100,000,000 lb a year of a product. If Company A were to carry out the project alone, the economic picture is illustrated in Table 1. The unit requires an expenditure of $6,000,000. The product would cost 4.7 cents per lb on the basis described. With the product selling at 6.5 cents per lb the project shows an annual profit of $1,800,000 a year and a cash flow (profit plus depreciation) of $2,200,000 a year. The project provides a 2.75-year payout or a 27.5% return (Investor's Method) if the sales for the 100,000,000 lb are immediate and the construction time a year and a half.

Two yardsticks have been chosen as measures of profitability—payout time and the Investor's Rate of Return. Payout (a widely used index with well-known shortcomings in its failure to reflect a true pattern of earnings, is defined as the number of years required to recover the depreciable investment from profits and depreciation. The Investor's Rate of Return (also known as Profitability Index or Interest Rate of Return) is the interest rate, compounded continuously, at which invested capital is repaid by a project. The relationship between the two methods is illustrated in Fig. 1.

Company B has also been making plans to produce the same product volume. The two companies get together and the plant is sized for 200,000,000 lb a year. Details are worked out as discussed. The inside battery facilities were factored at 0.6 and the offsite equipment was factored at 0.7 to provide the $9,300,000 capitalization for the joint unit. For simplification, the investment and operating costs are shared equally.

Table 2 shows that the manufacturing cost of the product is reduced by 0.3 cents per lb. Therefore, each partner has saved $300,000 a year in operating costs as a result of the joint venture. In essence, the fixed costs of production are now distributed over a larger volume to the benefit of both partners. Also, each partner in sharing half the capital requirement for the joint unit can now produce his 100,000,000 lb for a $4,650,000 investment, an investment advantage of $1,350,000 over the individual units. The payout for each partner is 1.92 years and the rate of return increases to 38%.

A closer look at the improved profitability of the project shows that 7% of the 10% increase in return is a result of the reduced investment. The lowered manufacturing costs are responsible for the additional 3%.

The necessary work to get agreement and

TABLE 1. Sole Company Venture.
(Basis: 100,000,000 lb per Year)

Process Investment—Inside Battery.....4.0 M
Outside Battery...2.0 M
Total.....6.0 M

	Dollars Per Calendar Day	Cents Per Lb Product
Material Cost		
Feed	9,000	3.3
By-Product	—1,900	—0.7
Net Material Cost	7,100	2.6
Manufacturing		
Operating Labor (3 Men/Shift) + Supervision	550	
Repairs—4% on Inside Battery, 2% on Outside Battery	550	
Utilities and Chemicals	2,740	
Overheads	880	
Depreciation—15 Year	1,100	
Total Manufacturing	5,820	2.1
Total Cost	12,920	4.7
Income	17,800	6.5
Profit	4,880	1.8
Profit + Depreciation	5,980	2.2
Construction Time	1½ Years	
Plant Life	10 Years	
Payout[1]	2.75 Years	
Investor's Rate of Return[1]	28%	

[1]Before income taxes and royalties.

TABLE 2. Joint Venture.
(Basis: 200,000,000 lb per Year)

Process Investment—Inside Battery.....6.05 M
Outside Battery...3.25 M
Total.....9.30 M

	Dollars Per Calendar Day	Cents Per Lb Product
Material Cost		
Feed	18,000	3.3
By-Product	—3,800	—0.7
Net Material Cost	14,200	2.6
Manufacturing		
Operating Labor (4 Men/Shift) + Supervision	630	
Repairs—4% on Inside Battery, 2% on Outside Battery	840	
Utilities and Chemicals	5,480	
Overheads	1,180	
Depreciation—15 Year	1,700	
Total Manufacturing	9,830	1.8
Total Cost	24,030	4.4
Income	35,600	6.5
Profit	11,570	2.1
Profit + Depreciation	13,270	2.4
Construction	1½ Years	
Plant Life	10 Years	
Payout[1]	1.92	
Investor's Rate of Return[1]	38%	

[1]Before income taxes and royalties.

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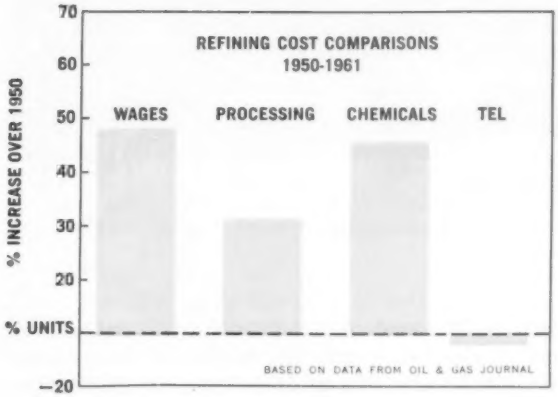

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arrangements for the partnership for the two receptive companies is well justified.

Contingencies and Economic Pitfalls

The examination of contingencies and economic pitfalls for a particular project should be a part of any evaluation. Let's weigh some of these considerations into our joint venture analysis.

Assuming the proposed plant requires high power consumption and process steam, the utilities are considered to be 40% fixed, i. e., independent of throughput. For simplicity the labor, repairs and overheads are defined as entirely fixed costs. These assumptions serve as the basis for allocating product unit costs as a function of throughput.

What are some of these pitfalls?

Establishing and projecting the market for a product is a difficult job. Early obsolescence, competitive position, geographical advantages or disadvantages and many other factors tend to perplex the forecaster's analysis. Here's what can happen to profitability if the market cannot support the full volume of our product.

A contingent marketing department forecast predicts that only 80% of the original volume may be sold. There are many valid reasons for this. Delays in working out process details or in getting the authorization approved can lose prospective customers whose timing made it necessary for them to go elsewhere for the product. Newly announced competition is on the scene. Satisfactory cheaper materials have entered the market.

Table 3 shows contingent economics for the sole company venture. The reduced product volume increased the product cost 4 cents per lb (Column B) and reduced the annual cash flow $660,000. The project payout is now 3.95 years with an 18.5% rate of return. Should the company recognize a 20% cut-off rate of return for such projects as this, the management could decide not to carry out the venture alone.

The effects of contingencies on the joint venture economics are shown in Table 4. In this case the reduced product volume increased the product cost 3 cents per lb and increased the payout to 2.64 years, but still shows an attractive 28.5% rate of return. The basic return of the joint venture (Column A) has provided a cushioning effect for this economic pitfall.

It is a good policy to include the effect of product price changes in any economic analysis. Suppose, for example, that a recent price change reduces the value of our product 5 cents per lb. The cost of the product, of course, remains the same, but the annual profit on the 100,000,000 lb volume is reduced by $500,000.

The profit penalty of the lower price decreased the rates of return on the sole company venture and the joint venture to 21% and 31% respectively. Again, the cushioning effect of aggregated capitalization is beneficial in providing a comfortable rate of return for the joint venture at lower product value.

All contingent factors do not necessarily depress the rate of return of a project. The Investor's Method, which recognizes the time value of money, clearly demonstrates the contribution to the overall return that results from minimizing the construction time for a unit. In other words, the attractiveness of the project is related to the time during which capital is being spent with no compensating income.

Regarding our project, the expeditious planning and coordination of engineering, purchasing, material delivery and construction for the unit could advance the commissioning date of the plant six months. The penalty of compounding invested capital prior to startup would thereby be reduced from 1½ years to one year.

Table 3. Analysis of Economic Pitfalls of Sole Company Venture

	A	B	C	D	E
	Base	Volume Off 20%	Price Off 0.5¢/lb	Shorter Const. Time	Start-Up Difficulties
Product Cost—¢/lb					
Material	2.6	2.6	2.6	2.6	2.6
Manufacturing	2.1	2.5	2.1	2.1	2.1
Total	4.7	5.1	4.7	4.7	4.7
Income—¢/lb	6.5	6.5	6.0	6.5	6.5
Profit—¢/lb	1.8	1.4	1.3	1.8	1.8
Profit+depr.—¢/lb	2.2	1.9	1.7	2.2	2.2
Annual Cash Flow—$M	2.18	1.52	1.70	2.18	2.18
Payout—Years	2.75	3.95	3.53	2.75	3.75
Investor's Return—%	27.5	18.5	21.0	29.5	21.0

Table 4. Analysis of Economic Pitfalls of Joint Venture

	A	B	C	D	E
	Base	Volume Off 20%	Price Off 0.5¢/lb	Shorter Const. Time	Start-Up Difficulties
Product Cost—¢/lb					
Material	2.6	2.6	2.6	2.6	2.6
Manufacturing	1.8	2.1	1.8	1.8	1.8
Total	4.4	4.7	4.4	4.4	4.4
Income—¢/lb	6.5	6.5	6.0	6.5	6.5
Profit—¢/lb	2.1	1.8	1.6	2.1	2.1
Profit+depr.—¢/lb	2.4	2.2	1.9	2.4	2.4
Annual Cash Flow—$M	2.40	1.76	1.90	2.40	2.40
Payout—Years	1.92	2.64	2.45	1.92	2.92
Investor's Return—%	38.0	28.5	31.0	41.5	28.5

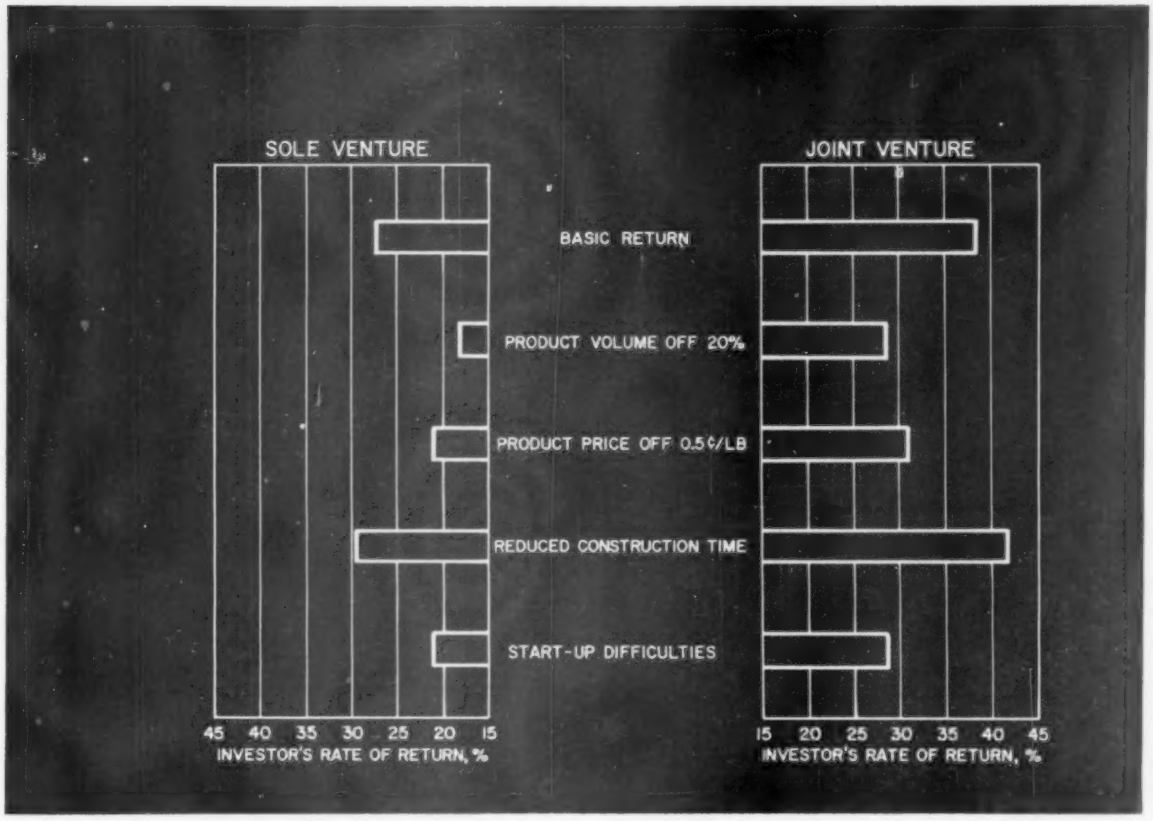

Fig. 2.

As a result of this, the rate of return for the sole company venture would increase 2% while the return on our share of the joint venture would increase 3½%. This effect is shown in Fig. 1.

Payout, as a measure of profitability, fails to reflect the advantage of reduced construction time. Note in Columns A vs D of Table 3 and 4 that the payout does not change.

The final pitfall illustrates the effect of lost sales due to unforeseen startup difficulties. Poor yields, product quality problems and equipment bottlenecks all represent conditions which could limit the product output and result in a loss of income early in the life of the project.

The examples shown in the tables illustrate what can happen to the project's profitability if startup problems delay the output of specification product for a year. Such a delay would decrease the rate of return on the sole venture to what has been described as a marginal 21%. The joint venture return drops to 28.5%.

The overall effects of economic contingencies are graphically shown in Fig. 2. Reduced product volume or price and startup delays all tend to place the profitability of the sole company venture in a borderline category. On the other hand, the bolstered basic advantage of the joint venture provides a comfortable margin of safety to cushion the everpresent pitfalls which depress profitability. Such an examination should encourage a company's entry into joint ventures since the optimum allocation of capital is, in part, geared to optimum insurance.

In the final analysis, the success of your joint venture will be directly related to your competence in economic evaluation and cost estimation and to your judicious selection of a partner.

About the Author

Louis R. Bechtel, a project engineer in the technical service department of The Atlantic Refining Co., Philadelphia, counts economic evaluation among his principal engineering interests. Before joining Atlantic in 1955 he was a development engineer with Firestone Tire & Rubber Co. He holds a BS in Chemical Engineering from Case Institute of Technology.

Predetermine Pile

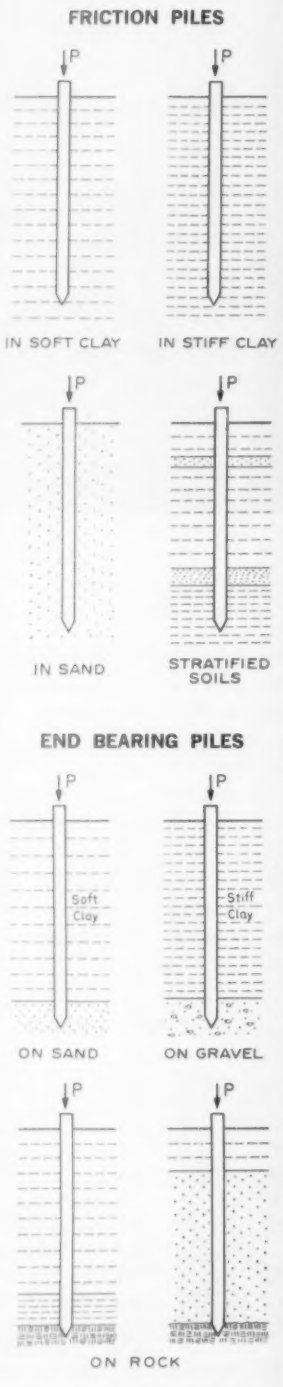

Fig. 1. Types of piles.

Without the time and expense of static load tests, design engineers now can establish safe loads for bearing piles with a rational method so new that it is not sufficiently well known outside the soils engineering profession.

This rational method, based on fundamental principles of soil mechanics comprehensively correlated with static load tests, in fact, is not fully treated in current textbooks on soil mechanics.

Predetermination of pile capacity by rational procedures has proved successful, whereas the widely-used dynamic pile formula method has been discredited, except for centain situations, because of serious inaccuracies in results.

The effectiveness of each method is reviewed here.

Classification of Piles

Piles derive their support from the soil either by skin friction along the embedded length of the pile, or by end bearing on the pile tip, or both. Both factors contribute to the support of almost every pile, but one or the other is often insignificant depending upon the particular pile size and soil profile. A pile of usual size embedded a significant length into a homogenous material, be it soft clay or sand, is usually considered a friction pile. A pile driven through a thick layer of weak soil and a short distance into an underlying strong material is fundamentally an end-bearing pile. Several different soil profiles typical of both friction and end-bearing piles are illustrated by Fig. 1.

Piles can also be classified on the basis of the kind of load they are to carry — compressive or tensile, sustained or short-duration, static or dynamic. Whether the pile is in a large closely-spaced group or a small widely-separated cluster is also important.

To narrow the scope of this discussion, it will be concerned primarily with the predetermination of ultimate compressive capacity of an individual pile, as would be measured by a static load test performed a few weeks after the pile is driven.

by John A. Focht, Jr.

Lengths This Modern Way

Dynamic Pile Formulas

The Engineering-News formula proposed by Wellington in 1888 for predicting the capacity of a pile based on its resistance to driving was not the first pile driving formula, but it has been used longer and more persistently than any other. This simple formula and its modifications (Eytelwein, Navy-McKay, etc.) were derived by equating energy (hammer weight X height of fall) to work (soil resistance X pile movement).

The formulas permit computation of the "soil-resistance" since the other factors are measurable. It is assumed in these formulas that soil resistance computed for the final increment of pile penetration is equivalent to the ultimate pile capacity under static loading. According to this assumption, pile loads greater than this computed soil resistance would cause additional pile movement.

Other more comprehensive formulas (Hiley, Pacific Coast Uniform Building Code, Canadian National Building Code, etc.) have also been devised. These formulas provide corrections for various factors which cause loss of some of the hammer energy and thereby reduce the amount of work done.

The detailed equations of the comprehensive formulas, as well as the simpler ones, are available elsewhere[4] and will not be repeated here. It is pertinent to note, however, that the so-called "comprehensive formulas" also are directed toward evaluation of soil resistance during driving of the pile without regard to the type of soil.

Adequacy of any method for predetermining pile capacity can be determined only by direct comparison with results of static load tests carried to failure. It is not sufficient to observe simply that foundations designed by a given procedure have "stood up," because the foundations may have been grossly over-designed or the design loads may never have developed.

Results of tests on a large number of piles in a variety of soils were analyzed by Terzaghi in 1942[2]. His results, which are presented in Fig. 2, were obtained from a number of different sources. They include both dynamic driving resistance and results of a static load test for each pile included. Ultimate pile capacities were computed from driving resistances by a number of different dynamic formulas to reveal which formula, if any, gave close agreement with the static tests. The wide scatter of the results, plotted in Fig. 2, shows that no dynamic formula — regardless of its complexity — will consistently and accurately predict pile capacity for all soil conditions.

In clay soils the soil resistance determined from driving resistance often differs materially from the soil resistance under static loading. The shear strength of a soft to firm clay is sharply reduced by the remolding effects of pile driving. During a nominal period after driving, the disturbed soil undergoes a strength increase due to consolidation. The soil resistance a few weeks after driving may be considerably more than the soil resistance during driving.

In a case from our files, timber piles 50 ft long driven into a thick bed of soft clay with sand layers were selected by the rational method to carry a design load of 17 tons. The first piles driven had almost zero capacity by dynamic formulas as the final driving resistance was only 3 to 4 blows per foot. Nevertheless, a load test performed two weeks later confirmed the ultimate capacity computed by the rational method. This type of difference is developed to some degree in all clay soils. Other reasons why dynamic formulas are generally unreliable are presented in full in the discussions of Reference 1.

In an analysis only of piles driven in sand, a soil not subject to the type of strength variation discussed above, Chellis[4] found appreciably less scatter than shown in Fig. 2. His study resulted in the comparison shown in Fig. 3. It is obvious from this figure that the "simple" Engineering-News formula and its modifications, even for piles in sand, result not only in extreme variations in the real factor of safety but also in some unsafe design. The data for the Hiley and Pacific Coast formulas in Fig. 3

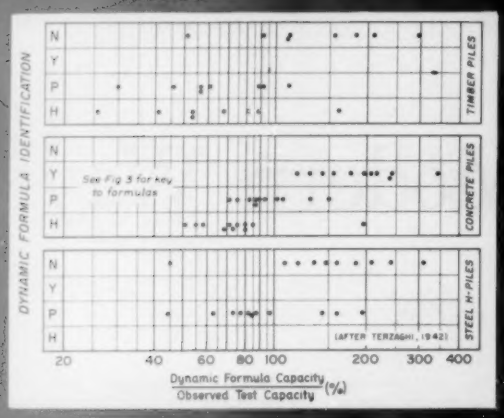

Fig. 2. Scattering of the ratio between formula capacity and test capacity for all soils.

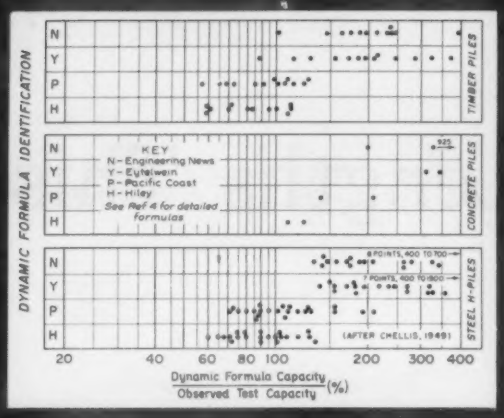

Fig. 3. Scattering of the ratio between formula capacity and test capacity for cohesionless soils.

do not show unsafe values and do exhibit a smaller range than for the simple formulas.

From this comparison of results from different formulas, Chellis concluded that the comprehensive formulas (Hiley, Pacific Coast, etc.) are "practical tools for use in pile foundation design (only) in soils in which the predominant driving resistance is supplied by cohesionless materials."

Some recent studies[6] have given support to Chellis' recommendation for selective use of comprehensive formulas. However, as Terzaghi pointed out in 1943,[3] dynamic formulas are popular because they reduce pile design to a very simple procedure. But, the price for the artificial simplification is very high.

Rational Method

The rational method for predicting individual pile capacity consists basically of evaluating the unit skin friction, or adhesion, and the unit end bearing to be expected for a particular site. The evaluation initially makes use of the familiar tools of soil engineering — undisturbed sampling and laboratory tests. The test data is then analyzed according to accepted soil mechanics theories which have been substantiated by direct correlation with a large number of static load tests.

The kind, number and depth of borings as well as the type and number of laboratory tests necessary for application of the rational method depend upon the site conditions, the characteristics of proposed structure, and a variety of other factors beyond the scope of this article. In every case, the soil data developed by the field and laboratory investigations must be compatible in scope and coverage with the problem at hand, in order to provide the foundation engineer with sufficient information on soil stratigraphy and properties of the pertinent soil strata.

One of the first papers outlining a fully rational procedure for predetermining pile capacity is by W. W. Moore (1949).[5] Since the publication of his paper, a number of other important papers have been published which provide the basic data on which the rational methods presently accepted by the United States are based. See references for partial list of significant papers.

The best example of the rational method, and one which is thoroughly documented, is the procedure for friction piles in soft to firm clay. The capacity of a friction pile driven into a body of soft or firm clay can be computed with reliability from results of unconfirmed compression tests (or other equally reliable tests such as vane tests or Swedishcone tests). Shear strength determined by one of these procedures and multiplied by the embedded area of the pile yields the total frictional capacity of the pile. For most piles in soft clays, the point resistance is small and can be neglected.

The validity of this method is well-substantiated by Fig. 4 and 5, which compare data from load tests to data from field and laboratory studies. In Fig. 4, the shear stress on the embedded pile area at failure in a load test, or the soil adhesion to the pile, is plotted against the soil shear strength determined by unconfined compression tests in the laboratory. Computed ultimate capacities of a large number of timber piles are plotted on Fig. 5 versus actual failure loads measured by load tests. The computed capacities in this figure were based on the Swedishcone.

The small scatter of the plotted points from the line of equality in both of these graphs clearly demonstrates that computed capacities of friction piles in soft to firm clays are very

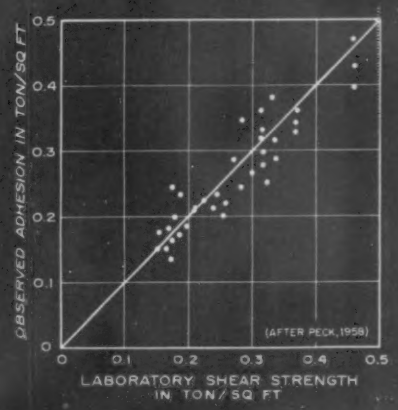

Fig. 4. Comparison of soil adhesion to pile and laboratory shear strength in soft to firm clays.

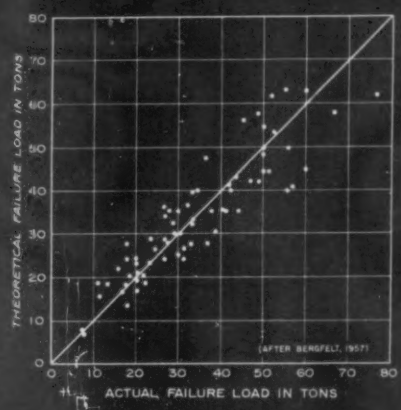

Fig. 5. Results of load tests on timber piles.

close to actual static load capacity. This conclusion has been confirmed by many other tests not included in these figures, some on piles as long as 333 ft.[7]

Results of a small number of load tests on piles driven into stiff clays in the Gulf coast region led our firm to conclude in 1955 that the maximum adhesion of a stiff to very stiff clay to a pile would be in the order of 1000 lb per sq ft. Since that time, published results of other load tests on friction piles in stiff clay have confirmed our tentative conclusion.[11,12]

Even though some of the tests have shown considerably higher values of adhesion, a maximum adhesion of 1200 lb/sq ft should be used for precast concrete and timber piles, and a maximum value of 1000 lb/sq ft is appropriate for steel piles.

The end bearing of a large-diameter pile in stiff clay is more substantial than for friction piles in soft clays. It is usually computed using the undisturbed soil shear strength in Terzaghi's bearing capacity equation, which reduces to:

$$Q_e = 7.4\, c\, A$$

where

Q_e = ultimate end bearing
c = cohesive shear strength
A = end area of the pile

Several different rational procedures have been suggested by various authorities for predicting the frictional support given to piles by sand.[5,6,9,12] Each of these is applicable whether the sand is present in a massive layer or in thin seams forming part of a stratified soil. Differences in these procedures lie principally in evaluation of the lateral earth pressure acting against the pile surface.

The end bearing to be expected for a pile driven into sand or gravel can be estimated with good reliability by the procedures outlined in two references.[6,9] Again, the bearing capacity equations of Terzaghi underlie these procedures.

A factor of safety must be applied to the ultimate capacity computed by any rational procedure to obtain an allowable pile load. If the soil conditions and strengths are well established and if the reliability of the computational procedure is at least "good to very good," a factor of safety of 2.0 is satisfactory. For less reliable procedures and for variable soil conditions, a factor of safety in the order of 3.0 is appropriate.

Comparison of Procedures

A general evaluation of the reliability of rational methods and dynamic formulas for different types of piles is presented in Table 1. This table is an interpretation of the published opinions of a number of authorities, in particular those included in the list of references at the end of this paper.

It is significant that for each type of pile a

TABLE 1. Reliability of Predetermined Pile Capacities.

TYPE OF PILE	TYPE OF ANALYSIS: Rational Method	TYPE OF ANALYSIS: Dynamic Formula
Friction		
In soft clay	Very good	Very poor
In stiff clay	Good to very good	Very poor
In sand	Good to fair	Fair*
In stratified soil	Good to very good	Very poor
End-bearing piles		
Thru soft clay into sand and gravel	Good	Fair*
Thru stiff clay into sand and gravel	Good	Fair*
Thru stratified soils into rock	Fair	Fair*

*Using a comprehensive type of formula.

rational analysis will produce results with a higher degree of reliability than a dynamic formula. Reliable soil borings and tests, as well as selection of the proper analytical procedure, are required to accomplish the precision indicated by Table 1 for the rational method.

The rational approach to design of a pile foundation does not preclude load testing to verify the predetermined capacities. Only by the accumulation of additional data from pile load tests carried to failure and by analysis of that data will the reliability of the rational procedures for some of the pile types be improved. The continual improvement of empirical correlations is the way that engineering advances.

Application of the rational type of analysis can be extended to almost any other problem of pile design, none of which can be approached by any of the dynamic-formulas. These design problems include pile capacity under tensile loads, possibility of settlement due to consolidation, effects of group action, variation of capacity with time, possibility of negative friction, and many others. Such facets of pile design are well beyond the scope of this paper, but solutions to these problems can be made by the rational method once detailed data on soil stratification and properties are available.

Conclusions

The rational method when properly applied is the most effective and reliable approach to the problem of predetermining pile capacity.

There is no published information supporting continued use of the Engineering-News formula or any of its modifications as an acceptable procedure to estimate pile capacity.

The comprehensive driving formulas may be used to predict pile capacity at locations where the predominant driving resistance is provided by cohesionless materials.

Load tests to failure remain desirable for large important projects to verify the pile capacities predetermined by the rational method.

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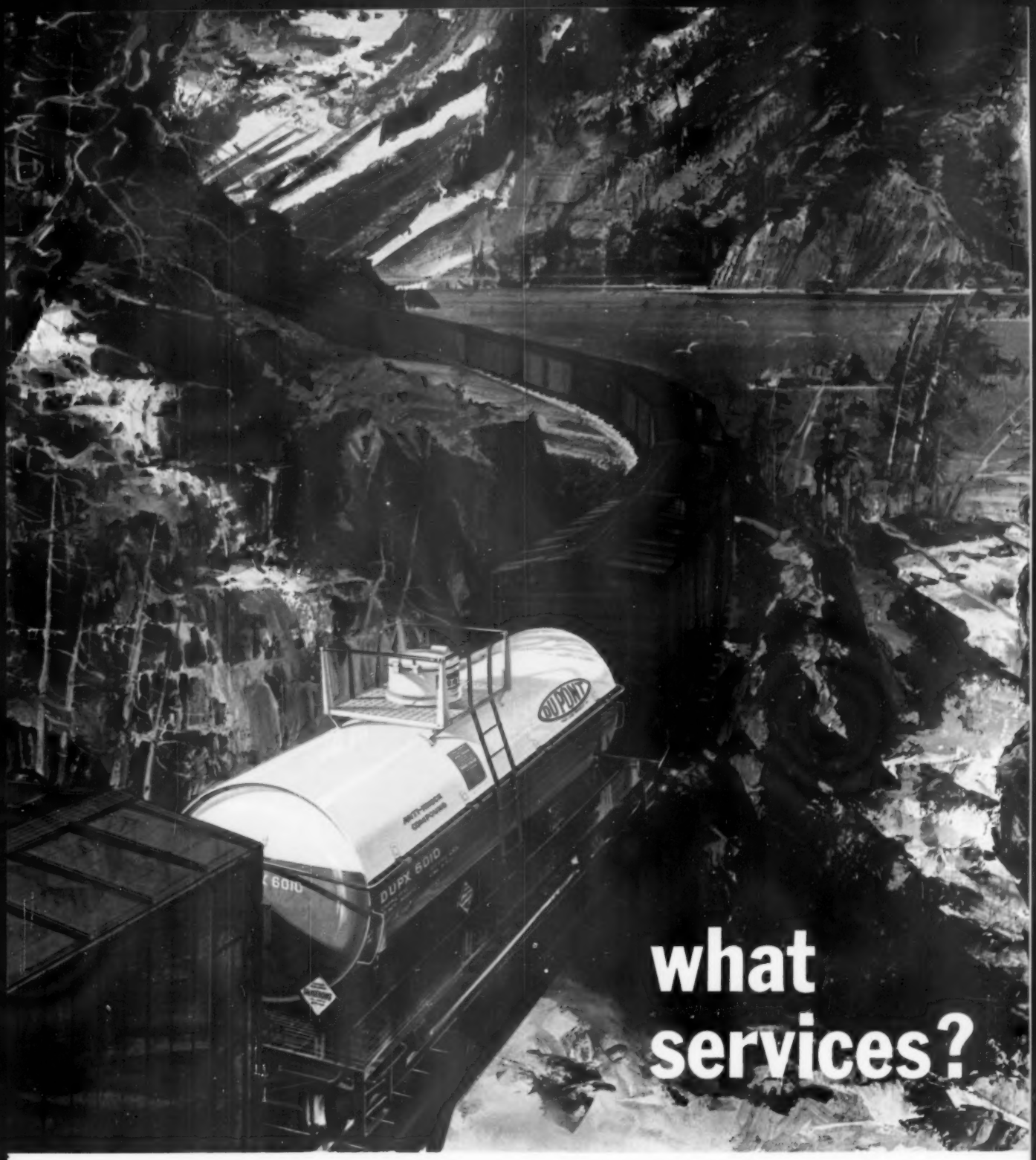
■

About the Author

John A. Focht Jr., since 1955 has been vice president and chief design engineer of McClelland Engineers, Houston, soil and foundation consultants. Previously he was soils engineer at the U. S. Waterways Experiment Station, Vicksburg, Mississippi, and senior soils engineer for Greer & McClelland, Houston. He holds a BSCE from the University of Texas and an MSCE (soil mechanics) from Harvard University. He is a registered professional engineer in Texas and Louisiana; member of the American Society of Civil Engineers, Tau Beta Pi, and Chi Epsilon; and has published several award winning papers in the soil mechanics field.



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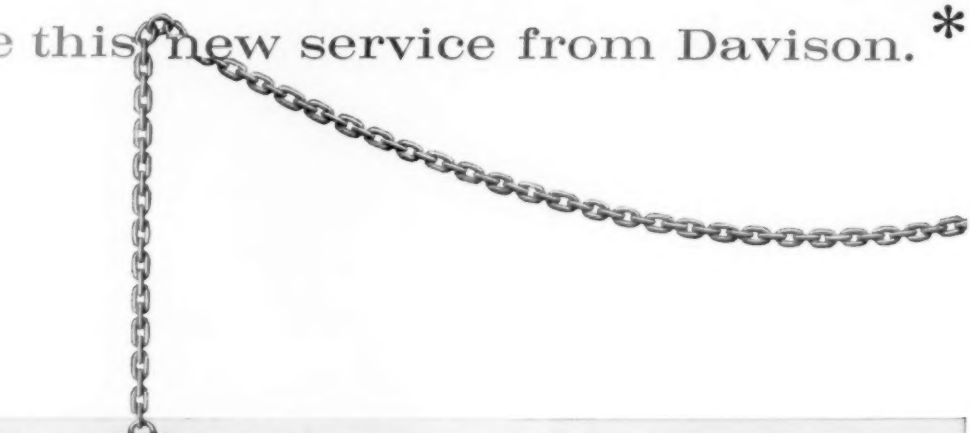

THE CATLOCATER

AUGUST, 1961

As a part of our continuing customer service program, Davison provides this bi-weekly availability bulletin on Equilibrium Fluid Cracking Catalysts. The sources listed herein and quantities available are constantly subject to change so that these figures are approximations only, based on the latest information available at the time of this mailing.

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by Dr. E. R. Smoley

How Much for Maintenance?

Mr. Engineer has graduated from a college or university with a bachelor of science degree in engineering. His college course has cost him from $8000 to $15,000, depending on the location, his scale of living and other factors. He has finished a four or five-year course of study during which time he fell behind in earned income compared with his high school associates who did not choose to go to college. This bypassed income could easily amount to $15,000 to $20,000, so in total let's say he has essentially invested $30,000 in his college education.

What does he have for this investment? He has established a good theoretical background in the fundamentals necessary for an engineering career. He has acquired a foundation based on mathematics, chemistry, physics, mechanics, electricity, the liberal arts, etc. With this base he enters the world where he obtains his first job.

Today, because of our rapidly expanding technology, he has excellent inducements and job opportunities, and he starts to add to his theoretical base the most important factor... experience.

The investment in a college education is starting to pay dividends already with his enjoyment of the work and the salary. Some of these dividends, however, must be reinvested toward continuing his engineering education. This is a relatively inexpensive continuing investment, too, but a most necessary one. I am referring to the obligation of each engineer to keep himself informed about what others are doing in his chosen field, and, perhaps more important, keeping up with technical developments in his field.

What does this involve? It involves building a personal engineering library by subscribing to and reading journals which carry the experience of others... which tell the story of new developments. The joining of and participation in the appropriate engineering society is also a worthwhile investment. In this way the engineer can further his opportunities to learn from lectures and the exchange of ideas with others in his field.

These are the minimum investments to consider just to keep up in an expanding technology. To advance, greater degrees of professional responsibility must be assumed.

What does it cost? Let's look at the initial investment, $30,000. This represents perhaps the largest single investment in the personal life of an engineer... probably ten times greater than his personal automobile. Preventive maintenance on the automobile costs about $200 a year.

What's the $30,000 worth? An automobile license costs more than $20 in most states. Most engineering society memberships cost less than $20. Yet according to the societies, only about 30 to 40% of the eligible engineers are active. An engineer thinks it reasonable to prepare an economic evaluation of a proposed plant for his company and include 2 to 3% of the total installed cost for maintenance, but he probably doesn't invest 0.5% annually on his $30,000 investment for an engineering education.

The right of free choice is open to you. Your professional development level is strictly a matter of your own choice and individual effort. But keep in mind that just as in company growth, the investment continues, the returns multiply and there is a continuous reinvestment.

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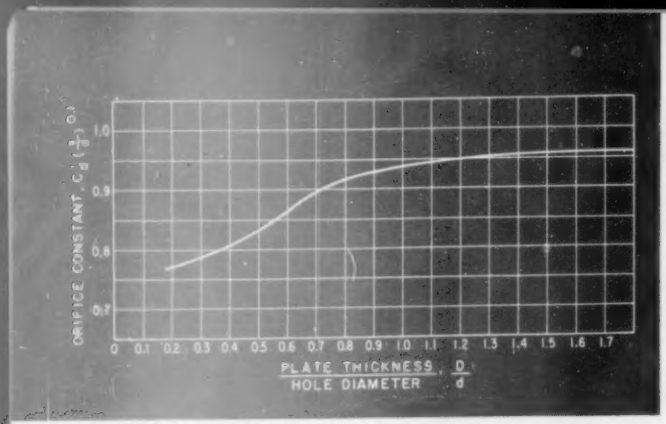


FIG. 4. Orifice constants[9].

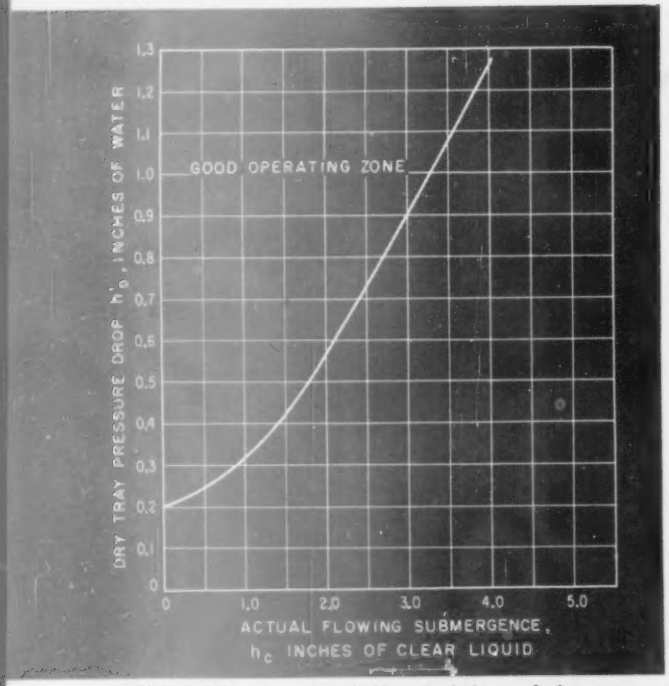
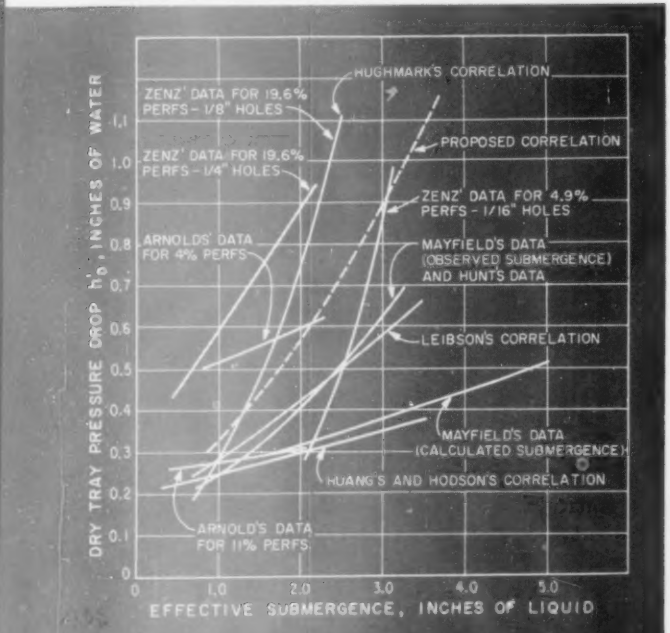


FIG. 5. Weepage correlation (minimum hole pressure drop).

FIG. 6. Weepage data.



What to Consider

A new perforated tray design method, proved out in numerous trays of various sizes in operation, employs best features of several previously published methods.[6,7,10]

Vapor-liquid contact on a perforated tray is somewhat different from that on a bubble tray. The bubbling zone fluid is much more uniform, with less channeling of vapor through the foam and less large droplets of liquid thrown above the foam level.

Laboratory data indicates perforated tray efficiencies are somewhat higher than comparable bubble tray efficiencies. This is due to less entrainment and a little higher point efficiencies. Tray efficiencies tend to increase with weir height, liquid path and hole spacing. Effect of gas and liquid rates is same as with bubble trays.[1] Amount of liquid back mixing is about same as for 3-in. bubble caps.

Fig. 2 (Part 1) shows important tray details. Tray diameter is initially assumed. Downflow is initially sized to give at least 5 sec. residence time for the maximum liquid rate. Area between inlet weir and outlet weir is bubbling area. A trial hole layout is then made and a tray spacing set. This initial tray layout is then checked in detail and modified where required. As in bubble trays, a cross flow layout is most desirable, but reverse flow, split flow or cascade flow may be resorted to if found necessary.

Mechanical Layout

1. An inlet weir should be provided to insure vapors do not break downcomer seal. It should be located just in front of downcomer baffle and directly below outlet weirs on adjacent tray. Height should be equal to downcomer baffle clearance but not as high as overflow weir. If inlet weir were high, leakage of liquid might occur from bottom of downcomer to tray below and downcomer capacity would be reduced because of high clear liquid level in the downcomer. Drainage holes should be drilled through bottom of inlet weir, which should be unnotched. Distance between downcomer and inlet weir should not be less than clearance below the downcomer baffle.

in Your Fractionator Tray Design

2. Downcomer baffle may be slanted 2 in. toward tower shell at the bottom. Clearance below baffle should be ½ in. lower than outlet weir height.

3. Calculated flowing submergence is defined as:

$$h_f = h_{w_o} + h_l + \tfrac{1}{2}\Delta \quad . \quad . \quad . \quad (10)$$

It should be between 2 and 4 in. Therefore, weir height will be between 1½ and 3½ in. A minimum weir crest of ½ in. is required and notching should be used if necessary to attain this. Weir should be adjustable ±½ in.

4. Minimum downcomer width at overflow weir is determined by the equation:

$$O_s = \sqrt{h_l t} \quad . \quad . \quad . \quad . \quad . \quad (11)$$

For center downcomer in split flow trays the width is double that determined by Eq. 11.

5. If cascade sections are used, each section must have the same flowing submergence and the same hole area.

6. In general, support rings should not extend into the downcomer area.

7. Levelness. Due to low pressure drop existing through holes and unobstructed liquid flow, out-of-levelness will tend to cause maldistribution of liquid and vapor as well as weeping. Care must be exercised in locating ring angles, providing good foundations and erecting the tower. Whenever possible, a tolerance of ⅛ in. should be specified. Maximum beam deflection should be ⅛ in. Long, thin towers with perforated trays should have less whip than towers with bubble trays. It is suggested that a vertical deflection of 2 in. per 100 ft of tower height be used.

A recent article[11] discusses out-of-levelness and gives some data obtained on a 5 ft 6 in. perforated tray. Tray was tilted so deck near the outlet was ½ in. higher than inlet side of tray deck. Amount of weepage was used as a measure of effect of levelness of performance. Except at low vapor or liquid rates there was very little effect of out-of-levelness. It would appear that for this size of tray out-of-levelness is not of great importance. However, more data is required before a firm conclusion should be reached.

8. Beams should be located whenever possible parallel to liquid flow to reduce the cross flow of vapor.

9. Minimum deck thickness should be 14 gage for excellent corrosion resisting material and 10 gage for normal corrosion resisting material. Thick trays tend to give lower dry pressure drops and, hence, higher weepage.

10. Holes are to be laid out on equilateral triangular pitch with base perpendicular to liquid flow. They should be punched or drilled carefully leaving no burrs. The smaller sized hole gives somewhat less weepage. Hole size of 3/16, ¼, ⅜ or ½ in. are recommended. Hole spacing should be three to four times the hole diameter — never less than two nor more than five.

These equations are useful in estimating the hole area for a given tray area:

$$n = \frac{166A'_B}{S^2} = \frac{184A_H}{d^2} \quad . \quad . \quad . \quad (12)$$

$$f = \frac{0.905}{\left(\frac{S}{d}\right)^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (13)$$

Hole layout is made using Eq. 12 and 13. Holes are to be located a minimum of 2 in. from tower wall and 3 in. from any weir. Eq. 13 indicates maximum hole area percent will be about 20%.

Process Design

After preliminary layout has been determined, tray variables are then checked in detail.

1. Minimum tray spacing for perforated trays will be similar to that for bubble trays,[5] being determined by size of beams required to carry the tray or by froth height. Froth height is determined by the Eq. 5. F in Eq. 5 is the F-factor at the bubbling area, A_B, and is defined as:

$$F = \frac{V}{A_B}\sqrt{\rho g} \quad . \quad . \quad . \quad . \quad (14)$$

Tray spacing must be greater than the froth height, Z_f, to give an acceptable entrainment quantity.

2. Outlet weir height is to give a flowing submergence (see Eq. 10) between 2 and 4 in. Maximum and minimum liquid rates are to be used and notching should be resorted to, if necessary, to maintain a minimum crest of ½ in. Use the following equation for an unnotched weir:

$$h_l = \left(\frac{Q}{2.98\, l_w}\right)^{2/3} \quad . \quad . \quad . \quad . \quad . \quad (15)$$

Equation to be used for a notched weir will depend on notch design. Equations for two common designs are given below (triangular notches).

Case for a completely notched weir where notches are not full of liquid:

$$h_l = \left(\frac{Q\, h_n}{1.11\, l_w}\right)^{2/5} \quad . \quad . \quad . \quad . \quad . \quad (16)$$

Case where weir is completely full of notches and liquid level is higher than top of teeth:

$$Q = 1.19\, \frac{l_w}{h_n}\, [h_l^{5/2} - (h_l - h_n)^{5/2}] . \quad . \quad (17)$$

3. Inlet Weir. Additional head, h_s, caused by the inlet weir, is determined by the equation:

$$\sqrt{h_s}\, [h_s + 1.5(h_{w_o} + h_l + \Delta - h_{w_i})] = \frac{Q}{2.98\, l_w}$$

. . . . . (18)

This equation applies only where inlet weir is completely submerged in the liquid. Inlet weirs need never be notched.

4. Total pressure drop through a perforated tray filled with liquid is given as

$$h_t = h_D + h_c \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

with h_c defined as actual flowing clear liquid height on the tray. Usually calculated clear liquid height is greater than actual height. h_c is obtained from the equation[1]

$$h_c = 1.65 + 0.19 h_{w_o} - 0.65F + 0.2L \quad . \quad . \quad (20)$$

Dry pressure drop, h_D, is obtained by using Fig. 4 and the equation

$$h'_D = \frac{0.003 \rho'_g\, V^2 (1 - f^2)}{C^2_d\, A^2_H} \quad . \quad . \quad . \quad (21)$$

and,

$$h_D = \frac{h'_D\, 62.4}{\rho_l} \quad . \quad . \quad . \quad . \quad . \quad (22)$$

Pressure drop per tray in psi is:

$$\Delta P = \frac{h_t \rho_l}{1728} \quad . \quad . \quad . \quad . \quad . \quad (23)$$

Eq. 20 is usual orifice equation corrected for approach velocity in terms of the readily available factors.

5. Weepage. A small dry tray pressure drop and a high flow submergence will allow liquid to leak through the holes. Using minimum vapor rate and maximum liquid rate, possibility of weeping is checked by use of Fig. 5. Operating condition should lie above curve which indicates no weepage.

Up to this point, determination of design factors has been straight forward and subject to only nominal uncertainty. However, determination of no weepage is subject to large uncertainties. Also, some weepage can be tolerated without appreciably affecting tray efficiency. Since there is so much uncertainty as to how to determine weepage, it is recommended the tray be designed for no weepage, i.e., for area above curve in Fig. 5.

Fig. 6 shows literature data[2,8,12,13] and three correlations.[6,7,10] Of the four sets of data plotted, Hunt et al[8] and Mayfield et al[12] report other than the calculated flowing submergence. Mayfield et al report a wet pressure drop head minus a dry pressure drop head. Data from this source is plotted twice on Fig. 6. Upper curve is obtained by using the effective submergence given by difference of the wet and dry pressure drops. The lower curve is obtained by using the calculated submergence, h_f. The data for Arnold et al,[2] and Zenz [13] was plotted using his observed submergence. As can be seen, the data scatter widely. Mayfield and Arnold used only air-water mixtures, while Hunt and Zenz not only used air-water but also non-aqueous mixtures.

For correlations shown, Leibson et al used Mayfield's data based on effective submergence but used as the calculated submergence. This is same as assuming Mayfield's aeration factor is one. The Hughmark et al[7] correlation is more conservative than Leibson's. The Huang and Hodson[6] correlation is Mayfield's data plotted vs calculated submergence. This is least conservative correlation.

Correlation recommended is a compromise between Hughmark's and Leibson's correlations. It is admittedly conservative, especially in view of fact some weepage can be tolerated. However, until some efficiency data is forthcoming evaluating how much weepage can be tolerated, it is better to design close to no weepage.

It was felt that using a calculated flowing submergence would be too conservative in view of the large difference shown by the two ways of plotting Mayfield's data. Hence, use of Eq. 20 was used to get an actual flowing submergence. This equation, developed by AIChE[1] for bubble trays, applies equally well to perforated trays.

The abscissa, actual flowing submergence, in Fig. 5 is used in terms of hot clear liquid rather than water to be conservative. There is very little data reported on anything but air-water

mixtures to show the effect of density, viscosity and surface tension on weepage. Zenz[13] reports more tendency for methyl alcohol to weep than water although Hunt[8] shows the reverse for some solvents. Using submergence in terms of clear liquid may compensate for this tendency.

6. Entrainment. At maximum vapor rate and minimum liquid rate, the entrainment, e, (lb of entrainment per lb of liquid) should not be over 0.10 as discussed under bubble trays. e is given by the equation

$$e = \frac{7200\rho_g}{Q'\rho_l\alpha}\frac{V^{4.2}}{[A_B(t-Z_f)]^{3.2}} \quad . \quad . \quad . \quad (24)$$

where Z_f is given by Eq. 5.

Eq. 24 is taken from the Hunt et al[8] correlation with the more familiar terms used. This is a similar correlation to that used for bubble trays, and discussed there. However, this equation gives appreciably less entrainment than the correlation for bubble trays and is in line with laboratory experience. See Fig. 1.

7. Downcomer restriction. Restriction to liquid flow in the downcomer is calculated in a similar manner to that for bubble trays and is given by

$$h_4 = \left(\frac{Q}{600A_d}\right)^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (25)$$

Restriction area, A_d, is measured at smallest point in the downcomer system. It is usually area between deck and end of downcomer baffle or between downcomer baffle and inlet weir.

8. Downcomer capacity. The downcomer is designed in a similar manner to that for bubble trays. Due to a finer froth being produced on perforated trays, some caution should be exercised in sizing the downcomer. It is recommended that minimum clear liquid residence time be 4 sec and minimum free height in the downcomer be 50%. See Fig. 2. Downcomer residence time is determined by:

$$\theta = \frac{449N}{Q} \quad . \quad . \quad . \quad . \quad . \quad (26)$$

Downcomer volume, N, is usually determined by an arithmetic average of downcomer area at top and at bottom of downcomer inside the baffle multiplied by the tray spacing. Free height ratio in downcomer is determined by the equation:

$$H = \frac{t-(h_t+h_1+h_4+h_5+\Delta)}{t} \quad . \quad (27)$$

Numerator of this equation is the free height. Downcomer capacity should be checked at highest vapor rate and highest liquid rate. If capacity is insufficient and bubbling area is tight, larger tray spacing is indicated.

9. Liquid gradient normally is negligible in perforated trays. In some very heavily loaded trays it could be important and the following equation should be used:[7]

$$\Delta = 0.05\frac{(3b+h_f)^3\mu QZ_l}{(bh_f)^3\rho_l} \quad . \quad . \quad . \quad (28)$$

Use maximum liquid in above equation.

10. Vapor distribution. To obtain proper vapor distribution, the ratio Δ/h_D should be below 0.4 and never above 0.6.

11. Fluctuations. Highest practical dry tray pressure drop should be used to dampen out effects of vapor fluctuations through the tray.

Summary of Design

Final design will be a compromise between various tray variables. The following loads will determine the indicated tray variables.

1. High vapor rate — total pressure drop, downcomer capacity, tray spacing, entrainment, tray diameter and hole area.

2. Low vapor rate — hole area, vapor distribution and weir height.

3. High liquid rate — weeping, downcomer capacity, vapor distribution, pressure drop, tray spacing, tray diameter and weir height.

4. Low liquid rate — minimum outlet weir crest and entrainment.

This method assumes vapor density is negligible compared with liquid density. When vapor density is appreciable, some equations must be modified as will be discussed in a later issue.

Vapor Velocity

An allowable vapor velocity is not used for either bubble trays or perforated tray design. It is convenient to use one, however, in determining first choice of column diameter. The diameter will be changed where initial details of tray layout indicate a different tray size. This initial size is conveniently determined by the equation

$$u_{max} = 0.15\sqrt{\frac{t'(\rho_l-\rho_g)}{\rho_g}} \quad . \quad . \quad . \quad (29)$$

This maximum vapor velocity is based on total superficial area of column without compensation for downcomer area.

The recommendation for designing to 10% entrainment is based on normal conditions met in conventional fractionation work. In some cases a much lower entrainment must be met.

(Part 1, published in the October issue, carried complete nomenclature and references for both Parts 1 and 2. Part 3 of this article will be carried in an early issue.)

■

Petro/Chem Engineer Announces Associate Editor

Dr. Clyde Berg, internationally recognized authority on design engineering and development, is now affiliated with PETRO/CHEM ENGINEER as associate editor in the area of petroleum and petrochemical processes.

For 20 years an engineering executive in the largest industrial research facility in Southern California, Dr. Berg now heads a technical development consulting firm in Long Beach, Calif., where he deals directly with major petroleum and petrochemical corporations.

Dr. Berg holds 101 U. S. patents and patents in seven foreign countries. These are widely licensed. He has published approximately 50 articles on processing and engineering fundamentals, including design optimization techniques, fluid processing, thermodynamics, mechanical design of complex systems and the dynamic equilibrium of fluid systems involving heat and mass transfer.

He is a contributing author to the SCIENCE OF PETROLEUM, Vol. 5, PROCESS INSTRUMENTS AND CONTROL HANDBOOK.

Dr. Berg has repeatedly traversed the gamut of multi-million dollar research and development projects from conception to commercial utilization and is a registered professional engineer in the State of California.

A native of Minneapolis, Dr. Berg graduated from the University of Minnesota in 1936 with BChE degree with high distinction. Continuing there for postgraduate work, he served as an instructor in the chemical engineering department and assisted in the physics department. He was awarded the Hormel Fellowship for the year 1939-40. In 1940, after obtaining his PhD, Dr. Berg joined the process design and development group of Union Oil Co. of California. In 1942 he was appointed supervisor for process development.

In 1949 he assumed management of the largest development department of its type in Southern California. In this capacity he was director of a separate research facility and in responsible charge of exploitation of patent assets, industry liaison, exploratory design, process evaluation pilot plant construction and operation, commercial plant design, liaison with contractor engineering and plant start-up.

In 1955 he assumed charge of the design division where under his direction major contributions were made to the development of key processes and he directed a technical and administrative staff with supporting personnel in a discipline of chemical engineering, cryogenic engineering, mechanical engineering, physics, mathematics and organic chemistry.

In 1960 he became director of Clyde Berg and Associates, technical consulting firm in the petroleum and petrochemical industries.

Dr. Berg is a member of AIChE, ASME, API, ACS, Tau Beta Pi, Sigma Pi and Phi Lambda Upsilon (Alpha Phi Sigma).

He is a member of the National Refining Committee of ASME, director of a Southern California Petroleum Division of ASME for 1961-62 and has served as chairman of nine technical symposia in the field of engineering. ■

by Dr. J. M. Marchello

Mathematics Workshop

Calculus/Part 3

D. The Derivative

To specify the direction of a straight line in the x-y plane, it is customary to give its slope, which is the trigonometrical tangent of the angle from the direction of the positive x-axis to the line. The slope of a curve $y = f(x)$ at the point $P(x,y)$ cannot be calculated by referring to the point P alone. Instead, it is necessary to resort to a limiting process much like that involved in the calculation of the area under a curve.

The limiting process of finding the slope of a curve is the basis of differential calculus. In Fig. 1, the slope of the curve, $y = f(x)$ at the point of $x = x_1$ is given by relation

$$\text{slope at } x_1 = \lim_{x \to x_1}\left[\frac{f(x_1) - f(x)}{x_1 - x}\right] = \lim_{x \to x_1}\left[\frac{\triangle y}{\triangle x}\right] \quad . \; . \; . \quad (1)$$

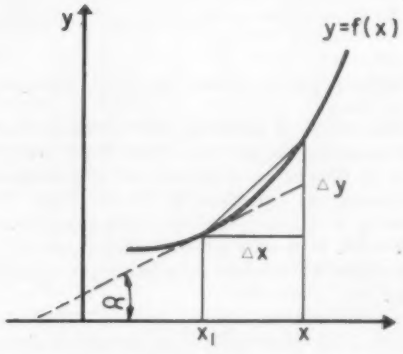


FIG. 1. The derivative as a limit.

The slope of the tangent to the curve is the limit of the difference quotient $\triangle y/\triangle x$ as the quantity $\triangle x = x_1 - x$ approaches zero.

The slope of the curve represents a new function of x which is denoted by $f'(x)$ and called the derivative of the function $f(x)$. The limiting process by which $f'(x)$ is obtained is called differentiation of $f(x)$. From the geometric interpretation,

$f(x)$ = height of the curve $y = f(x)$ at the point x.

$f'(x)$ = slope of the curve $y = f(x)$ at the point x.

The term "differentiation" comes from the fact that $f'(x)$ is the limit of the difference $[f(x_1) - f(x)]$ divided by the difference $(x_1 - x)$

$$f'(x) = \lim_{x \to x_1}\left[\frac{f(x_1) - f(x)}{x_1 - x}\right] . \quad (2)$$

Other notations for the derivative given in Eq. 2 are

$$f'(x) = D\,f(x) = \frac{dy}{dx} = \frac{d\,f(x)}{dx} . \quad (3)$$

E. General Rule and Some Elementary Forms for Differentiation

From the definition of a derivative, the general process for differentiation consists of taking the following distinct steps

1. In the function replace x by $x + \triangle x$, and calculate the new value of the function, $y + \triangle y$.
2. Subtract the given value of the func-

tion from the new value and thus find $\triangle y$, the increment of the function.

3. Divide the remainder $\triangle y$ by $\triangle x$.

4. Find the limit of this quotient when $\triangle x$, the increment of the independent variable, varies and approaches zero as a limit. This is the derivative.

In a like manner to that of integration, the operation of differentiation has been reduced essentially to a mechanical procedure by the compilation of tables of known derivatives. These tables are not extensive, since one can always determine the derivative, if it exists, from the general four-step rule given above.

A few of these forms are:

$$\frac{dc}{dx} = 0$$

$$\frac{dx}{dx} = 1$$

$$\frac{d(u+v)}{dx} = \frac{du}{dx} + \frac{dv}{dx}$$

$$\frac{d(uv)}{dx} = u\frac{dv}{dx} + v\frac{du}{dx}$$

$$\frac{d(v^n)}{dx} = nv^{n-1}\frac{dv}{dx}$$

A number of forms of this type have been worked out and are available in the many excellent textbooks and handbooks on calculus.

Solution to Problem 13

The change in entropy per pound of water heated at a constant pressure of one atmosphere from liquid at 32 F to vapor at 600 F can be carried out in three successive steps.

1. Heat the water from 32 F to 212 F, which corresponds to going from 492 R to 672 R.

$$\triangle S_1 = \int_{492}^{672} (1.00)\frac{dT}{T} = \ln\left[\frac{672}{492}\right]$$

$$\triangle S_1 = 0.312 \text{ Btu/lb R}$$

2. Vaporize the water to steam at 212 F or 672 R.

$$\triangle S_2 = \frac{\triangle H_{ev}}{T} = \frac{970}{672}$$

$$\triangle S_2 = 1.445 \text{ Btu/lb R}$$

3. Heat the steam from 212 F to 600 F, which corresponds to 672 R to 1060 R or 373 K to 589 K.

$$\triangle S_3 = \int_{373}^{589} \frac{C_p}{T}\,dT$$

$$\triangle S_3 = \int_{373}^{589} [8.22 + 0.15 \times 10^{-3}T + 1.34 \times 10^{-6}T^2]\frac{dT}{T}$$

$$\triangle S_3 = \int_{373}^{589} \frac{8.22}{T}\,dT + \int_{373}^{589} 0.15 \times 10^{-3}dT + \int_{373}^{589} 1.34 \times 10^{-6}TdT$$

$$\triangle S_3 = 8.22 \ln\left[\frac{589}{373}\right] + 0.15 \times 10^{-3}(589 - 373) + 1.34 \times 10^{-6}(\tfrac{1}{2})[(589)^2 - (373)^2]$$

$$\triangle S_3 = [3.760 + 0.032 + 0.139] = 3.931 \frac{\text{cal}}{\text{g-mol K}}$$

gal/g-mol K = Btu/lb-mol R

The molecular weight of water is 18.02 lb/lb-mol.

$$\triangle S_3 = 3.931/18.02 = 0.218 \text{ Btu/lb R}$$

Summing up these three steps,

$$\triangle S = 0.312 + 1.445 + 0.218 = 1.974 \text{ Btu/lb R.}$$

In other words, the change in entropy of water heated at one atmosphere from liquid at 32 F to vapor at 600 F is 1.974 Btu/lb R.

Problem 14, Automobile Price Variation

The price of used cars of a certain model increases by 2¢ per mile west from Detroit. Due to depreciation, the price of this model decreases at the rate of $2 per day. If a person is driving one of these cars toward the west at a rate of 400 miles per day, is the value of the car increasing or decreasing?

Dr. J. M. Marchello is professor of chemical engineering at the University of Maryland, College Park, Md.

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HPI Equipment

Advanced Head Protection

Topgard safety hats and caps are injection-molded with polycarbonate. The high impact engineering thermoplastic material provides impact strength of metals with natural resilience of plastic. Other features of Topgard hat line include high resistance to chemicals, extraordinary dielectric properties and long life through abrasion resistance that protects color and finish. Headgear complies with federal and ASA specifications. *Mine Safety Appliances Co.*
Circle number (41) on reply card

Alcohol Uses at a Glance

Chart shows specific uses for which specially denatured alcohol formulas have been authorized. This revised edition is based on alcohol regulations now in effect. Copies supplied to those requesting it on their own letterheads. *Commercial Solvents Corp.*
Circle number (42) on reply card

Arc-Free Static Starter

New static starter for motors, eliminating a switching arc in corrosive or explosive atmospheres, has been developed for use in the petroleum and related industries. Modular in concept, the starter uses a special silicon-controlled Trinistor rectifier which blocks conduction in the reverse direction. However, it provides complete control of conduction in the forward direction. Total control of a 3-phase inductive or resistive load is possible by proper arrangement of the rectifier units. Low-energy level signal needed to control a Trinistor unit makes it possible to monitor a load directly from a computer without preamplification. *Westinghouse Electric Corp., General Purpose Control Dept.*
Circle number (43) on reply card

Chemical Products Detailed

A 28-page brochure details products and facilities and provides technical data on all major product groupings of Jefferson Chemical Co. Major product areas covered are ethylene and propylene oxides, ethylene glycols, propylene glycols, ethanolamines, surfonic nonionic surface active agents, polyethylene glycols, urethane chemicals, morpholines, chlorine compounds, glycol base anti-freeze and caustic soda. Book available on letterhead request to company. *Jefferson Chemical Co., Inc.*
Circle number (44) on reply card

Chemical Resistance Report

How three different polyester resins and a room-temperature and heat-cured epoxy withstood immersion for up to one year in various corrosive aqueous solutions at elevated temperatures is reported in a 16-page bulletin. Of interest to those in the petroleum, chemical and other industrial fields, the report includes curves showing strength retention of the resins after immersion in a number of those solutions up to one year. The polyester resins are bisphenol A, isophthalic and general purpose. *Atlas Chemical Industries, Inc.*
Circle number (45) on reply card

Cleans Tank Interiors Fast

The reversing feature of a new hydraulic rotor jet unit doubles its effectiveness for fast cleaning of tank interiors in petroleum and chemical plants. Operation is completely automatic so persons need not enter the tank. Unit can be lowered into a tank suspended only by its hose. Impact of jets scrubs tank surface. *Sellers Injector Corp.*
Circle number (46) on reply card

Compact Oscillograph

The new 24-channel, direct recording oscillograph, the Model 1508 Visicorder, requires only 7 in. of rack height. Each channel is capable of recording individual static or dynamic phenomena at frequencies from d-c to 5000 cps. Any of 12 recording speeds may be selected before or during recording by means of push-button controls. Deflection

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Communicating your convictions gains better understanding, improved relations, greater results for engineers

Breathes there a man with soul so dead, who never to his friend has said, "Don't those lamebrains in the_____ Department every get ANYTHING right? . . . I very carefully wrote EVERYTHING down, very logically and clearly . . . didn't leave a thing out . . . and they still don't get my point!" — or words to that effect?

The only qualification you need for having voiced these sentiments is that you occupy yourself daily with one or more **people**, because it is with **people** that communications break down — people on either end of the chain of communication, whether they be employee or employer, buyer or seller, veteran or newcomer. **(See Footnote)**

Whether it be an internal or external message, verbal or written, a telephone message or a memorandum, a formal report or a business letter, technical or elementary, a progress report or a comparative, scientific analysis, the ground-rules are the same for successful communications.

Take our friend who is beset by "those lamebrains," for instance. Can he be so positive that it was the **other** end of the chain that bogged down? Perhaps he was **too complete** in his instructions, where simplicity would have sufficed. Perhaps the receiver merely needed short, concise directions, not the logical, careful rationalization of the writer. Perhaps his memorandum was clear to **him**, but maybe the "practical examples" he gave weren't so practical to the recipient because it was **outside his frame of reference**, background or experience. Maybe a telephone call would have been a more efficient medium of exchange in this instance.

The basic problem, then, is one of needing to transmit our beliefs, decisions, conclusions from us to someone **else**, and to have that other person **understand what we mean** — quickly, accurately, simply and — pleasantly.

Perhaps one of the cardinal rules for better communications, then, is **better understanding**: consideration for others, and a **desire** to understand another's viewpoint. Actually, this merely bespeaks the real origin of "fluid communications": **thought**, for thought plays a vital role in what we feel, observe, write, say, or demonstrate; and these **are** the principal means of communication available to everyone: thinking, feeling, observing, writing, saying, demonstrating. **(See Footnote)**

Does this sound like a monumental, life-long task? It is, and it isn't. It is **not** monumental unless you make it so by resenting it, and it **is** life-long, because as you change, as others change, as business changes, so do communication forms, vocabularies, meanings, frames of reference.

It is not sufficient in a competitive economy to **have** convictions; it is necessary to **sell** your convictions to someone who can either do something with them, or authorize you to do so. This, then is one of the chief values of communications; to help you accomplish your aims in engineering, in your professional life, more quickly, more productively, more successfully. Combined with your technical knowledge, your ability to perform and deliver, and your initative, communications can become the most valuable tool in your professional "workshop."

FOOTNOTE: For more detailed information, write for Booklet E-1, "Communicating Your Convictions," to WESTERN SUPPLY COMPANY, HEAT EXCHANGER DIVISION, P. O. BOX 1888, TULSA, OKLA. — and if there's a heat exchanger in your company's future, we'd appreciate a "line of communication" from you!

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of 8 in., peak to peak, is possible and traces are recorded at writing speeds over 50,000 in. per sec. *Minneapolis-Honeywell Regulator Co., Heiland Div.*
Circle number (47) on reply card

Compact Heat Exchangers

Compact heat exchangers, of hubless design, are subject of illustrated 4-page bulletin. Standard sizes, dimensions, and weights are listed for one, two, and four-pass Type 500 exchangers with shell diameters from 3¼ in. through 8¼ in. and lengths from 1 ft 4¾ in. through 6 ft 7 in. *Basco, Inc.*
Circle number (48) on reply card

Compression Tube Fittings

Presented in a new 20-page catalog are 25 items of Ridg-lok tube fitting line. Data on dimensions, pipe threading, and tube outside diameters for each part number of the various fittings are tabulated. Products are made in Type 316 stainless steel for corrosion-resistance and in brass for instrumentation, air, oil water and coolant lines. Sizes range from 1 through 16, for tubing of $\frac{1}{16}$ through 1 in. OD. *Parker-Hannifin Corp.*
Circle number (49) on reply card

Computer for Flow Ratios

New VRC unit provides direct measurement of flow ratios. Available in ratings of 3 to 5 psig, the computer replaces a conventional ratio device and two square-root-extracting devices in flow ratio pneumatic control systems. Instrument will sound an alarm or limit flow of one liquid when ratios exceed a critical point. *Republic Flow Meters Co.*
Circle number (50) on reply card

Control Valve Handbook

Comprehensive bulletin up-dates current data on split-body valves and gives complete information for specifying control valves. Complete specifications, dimensions and valve sizing data make Bulletin LB-4 a practical control valve handbook. It tells about the tight shutoff and flexibility and other features of this all-purpose control valve. *Conoflow Corp.*
Circle number (51) on reply card

Conveying and Tubing Elbows

New spec sheet describes line of conveying elbows and tubing elbows made of steel or aluminum. Standard bends are 45 deg and 90 deg, but any requirements can be furnished on custom orders. Size and model

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information and illustrative engineering drawings are provided. *Systems Engineering & Manufacturing Co., Inc.*
Circle number (52) on reply card

Cut Cleaning Costs

Service Bulletin No. 52B shows how to cut costs with "Do-It-Yourself Cleaning of Towers and Exchangers." With the help of a detailed diagram, bulletin tells how to make maximum use of a refinery's existing lines, tanks, product and process pumps and its own personnel for an economical cleaning setup. Factors which must be considered, such as refinery charge stock, type of metal, extent of soil deposits, local water conditions, etc., are also discussed. *Oakite Products, Inc.*
Circle number (53) on reply card

Data Logging System

Fast, accurate logging of data for permanent records and computer analysis from flow processes, test stands and special test set ups is obtained with new automatic digital data logging system. It scans and permanently records data from many points and can monitor continuous processes and power generation, permitting detailed analysis of such factors as cost, efficiency and uniformity. Unit primarily consists of a high speed analog-to-digital converter and necessary components to translate data into form required by output equipment. *Control Equipment Corp.*
Circle number (54) on reply card

Data on Multi-Point Gages

Multi-point gages for indicating draft, pressure, differential, and temperature are discussed in new bulletin, No. 322.11. Standard scale ranges are listed and diagrams and figures on mounting dimensions are provided. Installation data are also supplied. *Republic Flow Meters Co.*
Circle number (55) on reply card

Defoaming With Sonic Energy

New continuous-flow defoaming system uses sonic energy to destroy foam. Systems are furnished in a variety of diameters, lengths and foam handling capacities. Flanges are available for installation pipelines, in distillation reactors and other foam producing unit processes. System is operated by compressed air, steam or other gases and uses no electronics or moving parts. It is said to solve foam problems in chemical, petroleum and other liquid-processing industries. *Teknika, Inc.*
Circle number (56) on reply card

Describes Control Valves

New 8-page catalog details control valves in sizes from ¼ in. to 6 in. with body materials of ductile iron, cast iron, cast steel, stainless steel, bronze, monel and aluminum. Specifications are given along with flow charts and diagrams of various hook-ups. When to use a controller and when to use a positioner are explained. *OPW-Jordan Corp.*
Circle number (57) on reply card

Electro-Hydraulic Valves

Line of new, high precision valves features integral electronic control systems. System includes valve in all ASA sizes and ratings, electro-hydraulic actuator, a controller which provides signals to operate valve and necessary system equalization, and associated transducers. System response capabilities to 100 cps. *Security Valve Co.*
Circle number (58) on reply card

Engines and Compressors

"Compression and Power," new 14-page, four-color bulletin, presents complete line of engine and motor driven compressors, power engines, expansion engines, industrial jet-

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Solves Specific HEAT TRANSFER PROBLEMS...

Years of experience in engineering and fabricating of heat exchangers for the wide range of temperatures/pressures encountered in refining-petrochemical-natural gasoline plant processes enables EFCO to offer service-proved engineering design and guaranteed job rating. SunOlin Chemical Company is one of many process equipment users who are benefiting from EFCO's specialized experience and engineering efficiency.

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powered gas turbines, and En-Tronic control systems. Typical applications also illustrated and described. *Cooper-Bessemer Corp.*
Circle number (59) on reply card

For Temperature Regulation

Type G2 main valve, developed specifically for temperature regulation employing an auxiliary source of steam, air or water, is designed for heat exchangers served by steam at pressures of 15 psi or less and controls at practically zero pressure drop. The single-seated valve is available in sizes from 2 in. up to 8 in. with 125-lb flanges; double seat in 10 and 12-in. sizes. A variety of pilots can be used with the main valve to control flow of steam, air or water from auxiliary sources at 17 psi or more. *Spence Engineering Co., Inc.*
Circle number (60) on reply card

General Purpose Integrator

A solion tetrode is integrating element of this instrument, which is battery-powered and portable. It weighs only 5½ lb and measures 6½ x 8 x 8 in. Accurate to 1%, the GPI-100 has input impedance of 10KΩ and a frequency response from d-c to 10 kc. It accepts inputs to 1 v. *Texas Research & Electronic Corp.*
Circle number (61) on reply card

Forged Steel Gate Valves

Forged steel valves, manufactured in carbon and alloy steels in a variety of trim material combinations, are described in Catalog FV-1. Gate valve line includes OS&Y and inside screw rising stem valves in both bolted bonnet and union bonnet designs. Material specifications and trim materials along with tabulated dimensions of the various size valves available are presented for each valve type offered. Cut-away and cross-section illustrations show features and details. Working pressures are also tabulated. *Stockham Valves & Fittings.*
Circle number (62) on reply card

Keeps Tab on Catalyst

New "Catlocater" service in the form of a biweekly bulletin facilitates purchase or sale of equilibrium fluid cracking catalyst by petroleum refineries. It lists sources of catalyst and gives types and quantities available. Refineries supply information for bulletin by means of a mailing card. *Davison Chemical Div., W. R. Grace & Co.*
Circle number (63) on reply card

Fully Automatic Filter

Monovalve filter is a fully automatic gravity filter with a single, simple control valve. Construction, operation and applications of this filter, which stores its own backwash water, are described in new literature. The bulletin also contains typical flow diagrams and dimensioning data. *Graver Water Conditioning Co.*
Circle number (64) on reply card

Grease Summary

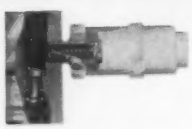
Basic principles, properties, types and rules for choosing and applying lubricating grease are summarized in a 32-page booklet. Effects of additives on the properties of grease are included. Types of greases discussed include calcium, sodium, sodium-calcium, lithium, aluminum, barium, non-soap thickened, and petroleum residua. *Bardahl Manufacturing Corp.*
Circle number (65) on reply card

Handling Wastes

Descriptions of systems for disposal of gaseous waste, liquid and gaseous waste, and liquid waste alone are given in the new bulletin on waste incineration and disposal systems. Photographs of units serving the petroleum, chemical and metallurgical industries are displayed and typical applications handled by each type of system are

CIRCLE SEAL

GAUGE SAVER



Isolates gauge from the circuit instantly if system pressure exceeds top gauge reading, or if gauge ruptures.
Many models available with ranges from 1 to 2400 PSI, to handle almost any gas or liquid.
Proof pressure 10,000 PSI, minimum burst pressure 20,000 PSI.

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AIR MOTORS. Variable speed, explosion-proof, reversible or non-reversible. Many models from 1/20th to 7 HP, and from 500 to 6000 RPM.

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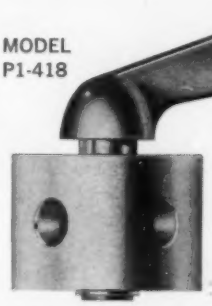
MODEL P1-418



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Positive sealing from —14.7 to 100 psi. Temperatures —40° to 350°F. Limited flow passages—minimum dead volume. Body anodized aluminum or 303 SS. Easy 90° rotation. ⅛" connections.

The perfect answer for chromatographic or precision test systems. Either P1-418 or P2-418 (double P1-418 without crossport connections) are ideally suited for selecting, back-flushing or alternating columns. Crossport leakage is entirely eliminated by specially machined O-Ring grooves. O-Rings top and bottom of valve completely eliminate body leakage. Rings are replaceable without removing valve from the line. No adjustment required... no valve seats to replace. Special 90° rotation handle visually indicates position.

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listed. *Thermal Research & Engineering Corp.*
Circle number (66) on reply card

High-Strength Refractory

New Kaogun-HS castable refractory, for pneumatic gun placement with low rebound loss and minimum dusting, produces a high strength monolithic body with excellent resistance to abrasion and thermal shock. Castable can be placed by wet or dry gun methods and has a recommended use temperature of 2500 F. High-alumina cement provides strong hydraulic bond. *Babcock & Wilcox Co.*
Circle number (67) on reply card

Hi-Temp Geon Pipe Fittings

Injection-molded fittings and flanges for new hi-temp Geon thermoplastic pipe can be used for process piping handling hot corrosive liquids, for hot water lines, and similar applications above the temperature range of regular unplasticized polyvinyl chloride (UPVC) piping. High-impact Schedule 40 and 80 fittings and flanges are now stocked in ½ through 2 in. pipe sizes, but the size range will be extended to 4 in. when larger pipes are commercially available. Schedule 40 pipe handles 125-lb pressure at 185 F safely. *Tube Turns Plastics Inc.*
Circle number (68) on reply card

Improved Packing Material

Improved Teflon TFE-fluorocarbon fiber, for braided packing for pumps and valves, is less sensitive to effects of operational and frictional heat and more receptive to gland adjustment than the earlier fiber. This results in greatly improved service life, especially in high-speed rotary pumps, and reduces need for special installation and break-in techniques. *E. I. du Pont de Nemours & Co.*
Circle number (69) on reply card

Metal-On Insulation System

Integrated pipe insulation that combines metal jacketing, high temperature calcium silicate insulation, and moisture barrier in one factory-fabricated unit is described in a new brochure, whose front and back covers are printed on the same type of aluminum, but a thinner gage, used on the insulation system. The brochure describes and illustrates the Metal-On insulation system, lists its advantages, and shows how it is installed in a single operation. Photographs show specific indoor and outdoor installations. Detailed

descriptions of the various components are given. Methods for coding pipelines are also described. *Johns-Manville.*
Circle number (70) on reply card

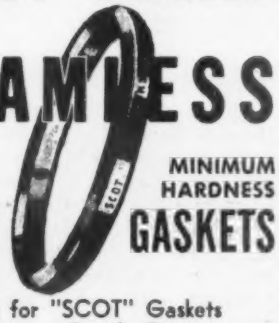
Miniaturized Solenoid Valve

Features of a new miniaturized, 2-way, normally closed, solenoid shutoff valve include: direct actuation, operating pressures to 3000 psi, full $\frac{1}{16}$ in. diameter orifice, explosion-proof case and bubble-tight sealing characteristics. Uses are in pilot plants, test systems, control circuits, etc. Actuating principle opens poppet even against high pressure with negligible pull of solenoid. *Circle Seal Products Co. Inc.*
Circle number (71) on reply card

Liquid Level Controller

Simplified controller for maintaining correct liquid level measurement can be applied to almost any size or type of vessel. It uses the Geiger-Mueller principle of radiation detection. Sensing heads are housed in thick steel tubes to meet explosion-proof requirements. This construction and operating principle permits unit to be used as a radiation monitor for industrial areas. *Ohmart Corp.*
Circle number (72) on reply card

"SCOT" FORGED SEAMLESS RING GASKETS



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For ring Groove Flanges forged from reforging billets in the following materials in stock: Soft Iron, Copper, Aluminum, Inconel, Monel, Nickel; 1¼ Cr ½ Mo., 2¼ Cr 1 Mo., 9 Cr 1 Mo. 304, 310, 316, 321, 347, 405, 410, 430, 502, 304L, 316L, Nickel L, Kel F, Teflon.

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P. O. Box 30, Bell, California

New Secondary Amines

New series of secondary amines, tradenamed Alkams, is now available in development quantities from UOP. Included are N-(1-methylheptyl)-ethanolamine; N,N'-bis(1-methylheptyl) - ethylenediamine; N-sec.- butylaniline; Bis (1-ethyl-3-methylpentyl) amine; and N, N'-bis (1-ethyl-3-methylpentyl) diethylene triamine. They have broad potential applications as organic intermediates, cationic flotation agents, curing agents for epoxide resins, cross linking agents for polyurethane foams, dispersants, emulsifiers and solubilizing agents. *Universal Oil Products Co.*
Circle number (73) on reply card

Process Control Systems

Automatic process control systems for HPI applications are described in a 6-page technical brochure. Characteristics of these systems and typical system specifications are presented, along with techniques for data transmission, display and data-coding. *Electrodynamic Instrument Corp.*
Circle number (74) on reply card

Process Programmer

Dynak process programmer, a one-knob controller of multiple, sequential processes in a process or machine, is detailed in new spec sheet. Unit is used for test equipment or for startup or shutdown sequencing. Knob turns a camshaft through 360 deg, and series of cams acts in predetermined sequence upon interchangeable pneumatic valves or microswitches that control remote devices. *Dynak, Inc.*
Circle number (75) on reply card

Proportioning Pumps

Proportioning pumps for controlled volume pumping of chemical solutions, slurries and liquefied gases have new automatic adjustment. With Strokontrol there is no sacrificing of stroke length or pump capacity to achieve adjustment while running. A totally enclosed hypocycloidal gear arrangement provides power transmission and capacity adjustment from zero to 100% of maximum. Pumps are driven by standard electric, rotary air or variable speed drives. *Jaeco Pump Co.*
Circle number (76) on reply card

Pump Repair Manuals

Manuals outline head repair instructions for both end-mounted

For Speediest Repair of Corrosion Leaks in Pipe

JUNIOR EMERGENCY PIPE CLAMP

Repair pipe leaks QUICKLY!

Speediest application — slotted lug permits the single plated bolt to slide instantly into place.

A companion to the old reliable Emergency Pipe Clamp that has served industry for a half century, the JUNIOR, a single bolt clamp, is 2⅞" wide. Undersells most band-type clamps.

Made of malleable iron, ruggedly proportioned, with full-length hinge along one side. Formed to exact pipe size—no bending. The recessed pressure-equalizing gasket, entire width of clamp, is cemented in. A lasting installation. 2" pipe size—$1.80; 2½"—$2.20; 3"—$2.30. Write for new circular on the Junior.

SKINNER-SEAL EMERGENCY PIPE CLAMPS for safe, sure lasting repair of splits and rust holes in pipe. No pressure too high. Anyone can apply in a few moments. Made in all sizes, ½" to 12", for steel and C. I. pipe. Stocked by practically all oil supply stores.

Send for catalog!

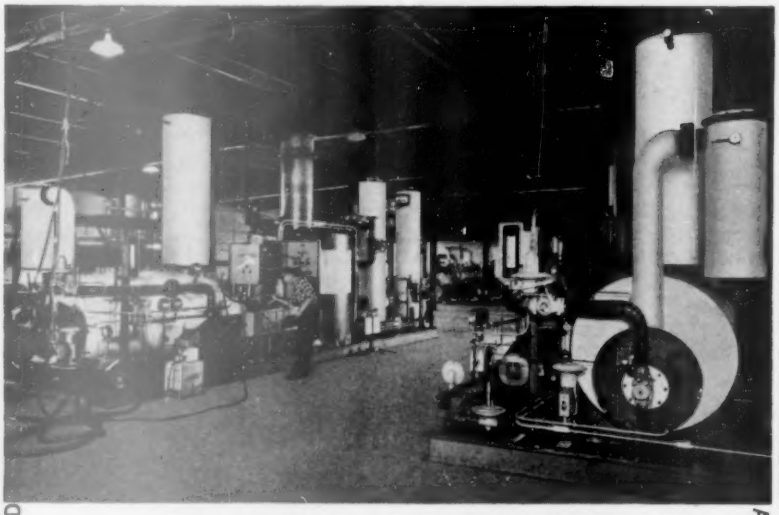
M. B. SKINNER CO.
SOUTH BEND 21, INDIANA

EVEN THE BIG ONES ARE FACTORY ASSEMBLED AND THOROUGHLY TESTED AT GAS ATMOSPHERES

The pair of 10,000 cfh high-purity nitrogen generators pictured below is undergoing complete factory testing prior to shipment to the customer. This is standard practice at Gas Atmospheres.

GENERATORS MUST EXCEED SPECIFICATIONS in production, gas purity, and dryness. This rigorous testing assures buyers of quick and easy start-up without job-site disorder, and it cuts servicing and maintenance to the bone.

GAS ATMOSPHERES ORIGINATED PACKAGED GAS GENERATION SYSTEMS by increasing the productivity of various components, consolidating operations, and designing the unit into as compact an area as possible. This means smaller generators today produce greater volume, and the entire unit can be factory assembled on a common base and shipped and installed as a complete unit.



Two compact 10,000 cfh high-purity packaged nitrogen generators on test floor at Gas Atmospheres Assembly Plant.

IF YOU USE GAS, EVEN IN SMALL AMOUNTS, it might pay you to produce your own with a modern gas generation system. It costs nothing to have your operation checked out by America's foremost designer and builder of packaged gas generation systems. Just call or write *Gas Atmospheres, Inc., 5353 West 161st Street, Cleveland 35, Ohio.*

gas Atmospheres, inc
equipment for producing industrial gases

PACKAGED GAS GENERATORS PACKAGED GAS GENERATORS PACKAGED GAS GENERATORS PACKAGED GAS GENERATORS PACKAGED GAS GENERATORS PACKAGED GAS GENERATORS PACKAGED GAS GENERATORS PACKAGED GAS GENERATORS PACKAGED GAS GENERATORS PACKAGED GAS GENERATORS

sealed and packed industrial pumps. They specify tools to be used and give complete disassembly and reassembly instructions along with hints on cleaning and inspection and important general information. Step-by-step repair procedures are presented. *Roy E. Roth Co.*
Circle number (77) on reply card

Recording Instruments

Complete specifications for the proper selection of recorders are presented in new publication. It covers full line of direct- and servo-operated, switchboard and portable recorders with information on 19 different types of single and multi-pen, ink and inkless, strip and round chart instruments. Describes recorders in accuracy classes of ¼, 3/10, 1, 2, and 3%. *General Electric Co.*
Circle number (78) on reply card

Refractories Directory

The 1961 Product Directory of the Refractories Industry in the United States lists 3548 different brands of refractories for lining industrial furnaces. The 224-page directory has a company-by-company breakdown of products. Special sections give manufacturer's names and addresses; plant locations by state and city; product divisions; and a complete list of brand or trade names. $4.50. *The Refractories Institute.*
Circle number (79) on reply card

Straight Flow Snubbers

Series of snubbers designed for the new turbo-charged engines operate on a straight flow snubbing principle. Each is engineered for a particular level of noise suppression. Available in pipe sizes from 8 in. through 30 in., with larger pipe sizes built on specification. Minimum pressure drop across the exhaust means more usable horsepower. *Burgess-Manning Co.*
Circle number (80) on reply card

ARKANSAS LOCATION

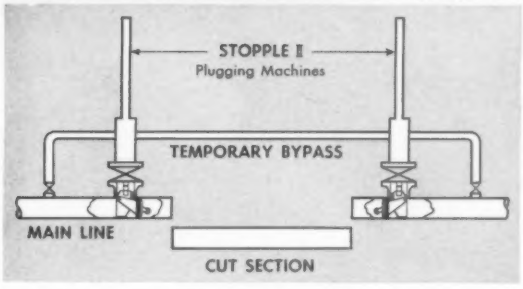
3 — Worthington 3500 CFM air compressors, 24 x 15, Model #LTC-4, 500 HP gas engine drive.

1 — Chicago-Pneumatic 3060 CFM air comp., 60 PSI, #19-32-30-18x24, steam driven.

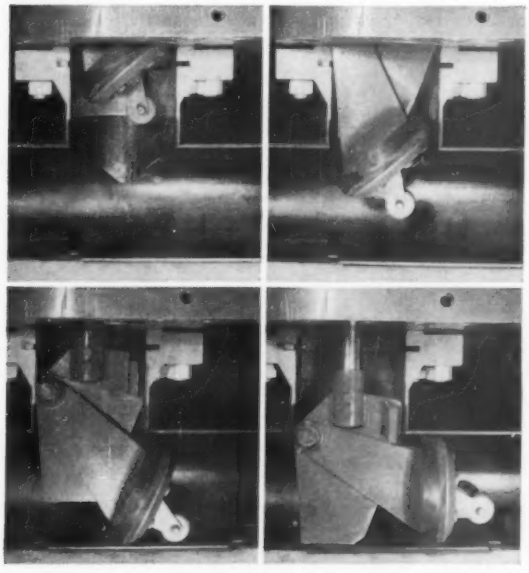
20 — 28,000 gal. horiz. steel tanks, 11' x 38' ASME 75 PSI WP.

20 — Large steel API heat exchangers.

PERRY EQUIPMENT CORP.
1428 N. 6th St. Phila. 22, Pa.
POplar 3-3505



❶ "This method of plugging a line and bypassing the flow has been used extensively in plant and field operations with WMSon tapping and STOPPLE equipment. Many costly shutdowns have been avoided. Now, WMSon engineers have re-designed and improved the STOPPLE Plugging Machine. Result . . . the all new STOPPLE II . . . offering hydraulic operation, improved, simplified construction, and economy—**real** economy!"



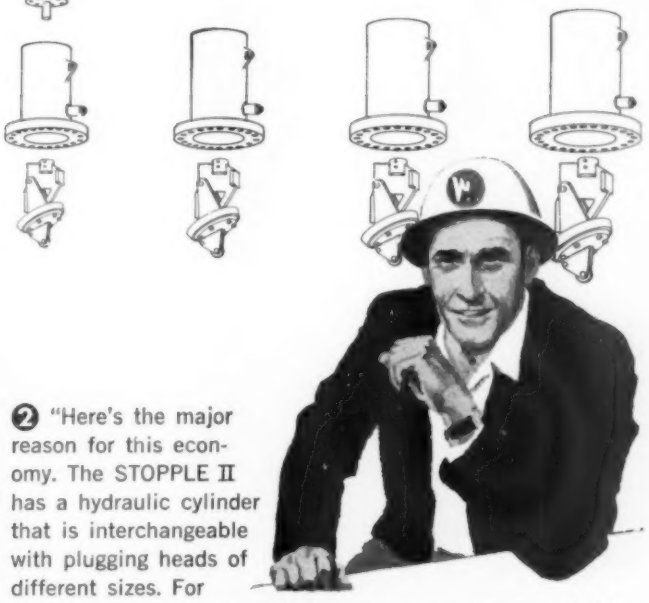
❸ "Here's how STOPPLE II works. After the tap is made, the STOPPLE II is mounted on a WMSon SANDWICH Tapping Valve, and the plugging head is lowered into the line, stopping the flow completely. New single link construction of the plugging head offers built-in simplicity . . . and strength for high pressure plugging."

NEWS FROM DOWN THE LINE!

NEW economy
NEW improved design
NEW interchangeable plugging heads . . .

WMSON'S ALL NEW STOPPLE® II

Plugging Machine for piping modification or repair WITHOUT SHUTDOWN!



❷ "Here's the major reason for this economy. The STOPPLE II has a hydraulic cylinder that is interchangeable with plugging heads of different sizes. For example, one hydraulic cylinder can be used on a 14", 16", 18" or 20" line by using it in combination with a plugging head and housing of the proper size."

•

WMSon STOPPLE II with hydraulic operation is available in sizes 8"–30". The 4" and 6" units are hand operated. Single link is standard in all sizes. Write for additional information and specifications: Write Dept. B for Bulletin A-513.

U.S. AND FOREIGN PATENTS AND PATENTS PENDING

T.D.Williamson,Inc.

P. O. BOX 40 • TULSA 2, OKLAHOMA

REPRESENTATIVES AROUND THE WORLD

FOUR-LETTER "INSURANCE POLICY"

RECOGNIZED AND RESPECTED BY ALL PIPE LINE MEN

Where can you buy an insurance policy that offers more in protection than the Gaso name on a pipe line pump?

The completeness of the Gaso line insures a type and size precisely suited to your conditions. Gaso's 46-year performance record insures extra years of low-cost trouble-free service. And Gaso policy insures immediate parts for every standard model ever made, even those still operating after a quarter century or more of severe service.

It is the assurance of complete satisfaction and the certainty of an extra return on the pump investment that explain why Gasos are specified as standard equipment in the lines of so many leading operators.

GASO PUMPS
for every oil industry need

DISTRIBUTORS

Farmington, N. M.—Gaso Pump & Burner Mfg. Co. Shreveport, La., Odessa Texas, Brookhaven and Tinsley, Miss.—W. L. Somner Company • Houston, Texas—Texas Pump & Compressor Company • Wichita Falls, Texas—Pump Engineering Co. • Evansville, Ind.—Hague Equipment Co., Inc. • Long Beach and Bakersfield, Calif.—Power Pumps, Inc. • Casper, Wyoming—Lufkin Foundry & Machine Co. • Edmonton, Alberta—Lufkin Machine Co., Ltd.

Write for Our Latest Catalog

GASO PUMP & BURNER MFG. CO.
FIRST & LANSING STS., TULSA, OKLA.
Export Office: 2612 Empire State Bldg.
NEW YORK, N. Y.

TAPECOAT® PROTECTION...

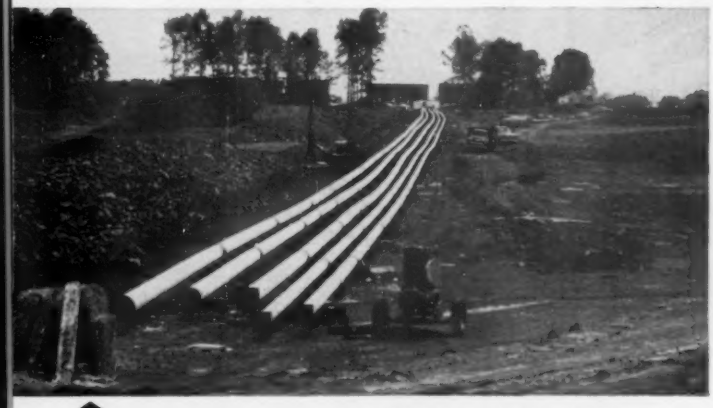
Works for You Anywhere!

NATURAL GAS lines at compressor and meter stations give years of maintenance-free service when protected by TAPECOAT, the coal tar coating in handy tape form.

GAS DISTRIBUTION lines of large diameter can readily be protected with TAPECOAT to withstand the abrasive and corrosive climate in underground service.

CABLE AND CABLE SPLICES in communications service are effectively and economically protected by TAPECOAT.

Lines in **OFF-SHORE DRILLING** operations need joint protection equivalent to the mill-wrapping on the pipe. TAPECOAT is most economical because it gives lasting protection in underwater service.



AIRPORT FUEL LINES need the quality joint protection assured by TAPECOAT. It is easy to apply by spiral or "cigarette" wrapping depending on the size of the pipe. No training needed.

UNDERGROUND GAS STORAGE facilities can be "buried and forgotten" when protected by TAPECOAT. Note protection of tanks, pipe and pipe joints.

STEEL MILL water lines in this new plant are joint-protected with TAPECOAT. TAPECOAT can be used to advantage to protect any steel surface in underground service, as proved since 1941.

Lines buried in cinders in **RAILROAD YARDS** need the sure protection provided by TAPECOAT. There's a size for every purpose from 2" to 24" in width.

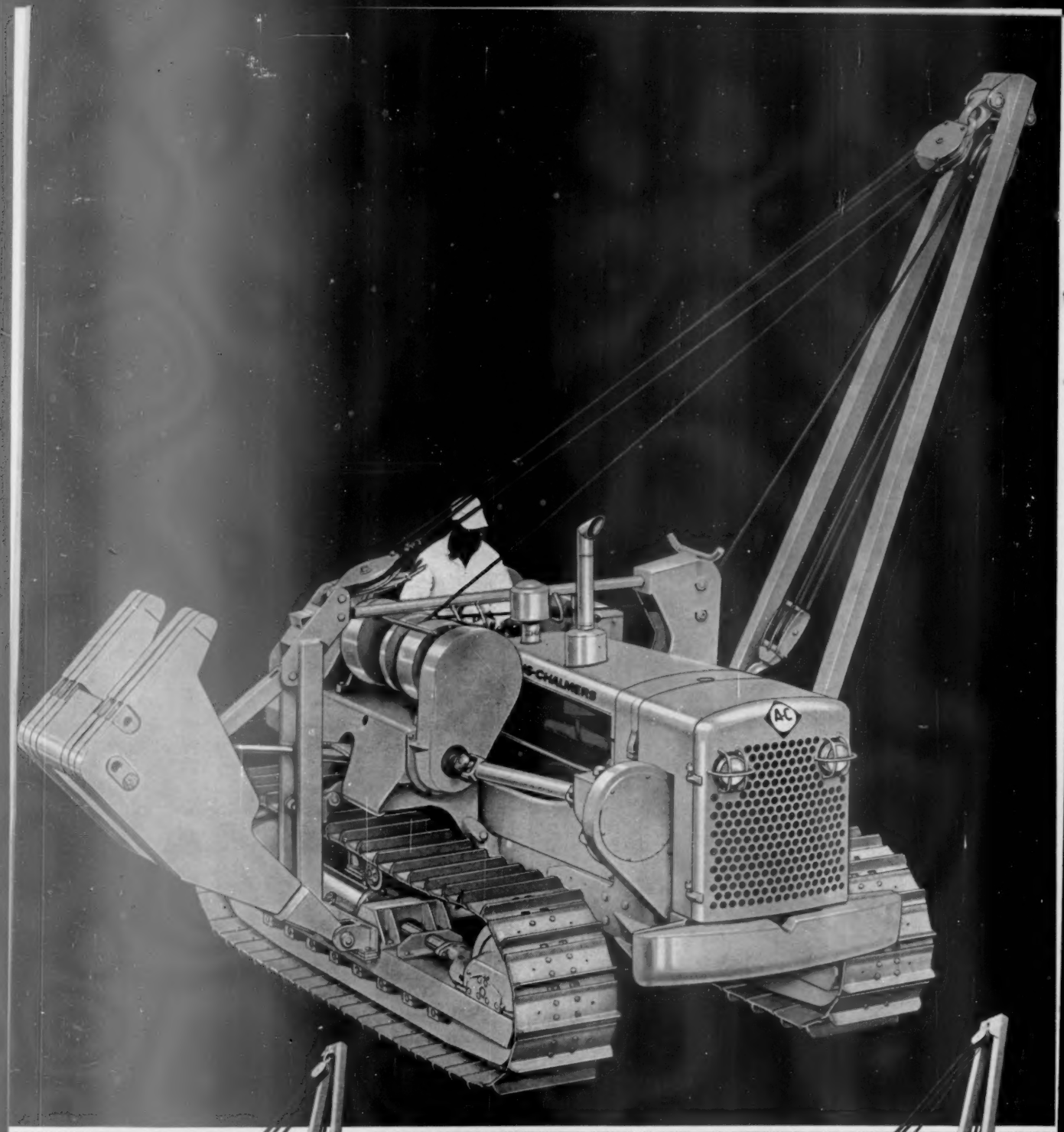
Write for full details today

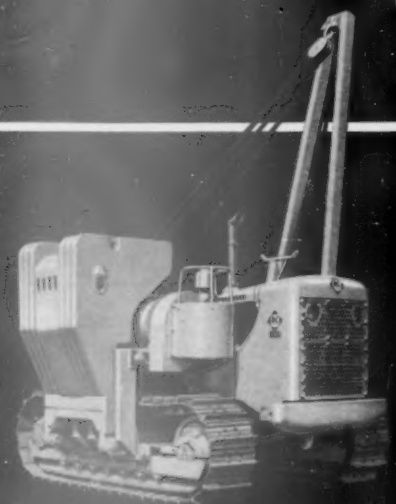
The TAPECOAT *Company*

Originators of Coal Tar Coating in Tape Form

1567 Lyons Street, Evanston, Ill.

Manufactured and Distributed in Canada by
The Tapecoat Company of Canada, Ltd.,
25 Haas Road, Rexdale, Ontario.



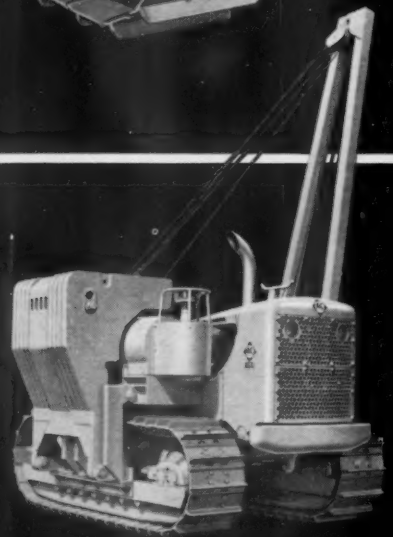


HD-16 TORQUE CONVERTER SIDE BOOM TRACTOR

Weight: 59,010 lb with full set of counterweights

Hp: 150 net engine hp

Lifting capacity: 78,000 lb at 4-ft overhang



NEW! 111-H.P. TORQUE CONVERTER BOOM TRACTOR

Allis-Chalmers—pioneer leader in torque converter tractors—now offers the HD-11 side boom tractor with torque converter drive. Pipeliners were quick to accept the advantages of this smooth-acting drive in Allis-Chalmers big side boom tractors. Today, these advantages are yours in this Allis-Chalmers medium-sized model.

Wherever you're using a side boom tractor in the 14- to 17-ton range—on medium-inch cross-country lines, small feeder lines, big-inch stringing work, oil or gas gathering lines—you can now get the advantages of torque converter drive with the new Allis-Chalmers HD-11. On cradling, stringing, hauling or dozing, this torque converter tractor will give you power and smoothness that no other tractor near its size can match in any terrain. In addition, with front power take-off, side boom is under full power control at all times.

You get the best side boom in the business with internal-expanding brakes for safe, sure operation . . . quick-on, quick-off, pin-connected boom fittings . . . safety-link, hydraulically controlled counterweight. In addition, you get the output-boosting advantages of Allis-Chalmers new 10,000 engine for greater power, lower fuel cost . . . new hydraulic power steering for easy, finger-tip operation . . . new oil master clutch for better wear, longer life. HD-11 side boom tractor is also available with direct drive.

Call your Allis-Chalmers construction machinery dealer for a demonstration. *Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.*

HD-11 TORQUE CONVERTER SIDE BOOM TRACTOR

Weight: 35,000 lb with full counterweight
Hp: 111 net engine hp
Lifting capacity: 40,200 lb at 4-ft overhang

HD-21 TORQUE CONVERTER SIDE BOOM TRACTOR

Weight: 78,250 lb with full set of counterweights
Hp: 225 net engine hp
Lifting capacity: 127,000 lb at 4-ft overhang

STEP UP YOUR

Performance
Operator comfort
Wearability
Ease of maintenance
Reliability

WITH

ALLIS-CHALMERS

POWER FOR A GROWING WORLD

Centrifugal Compressors—1000 hp to 15,000 hp · Engine, motor, or turbine drive; single or multi-stage. · Service: Pipeline booster, storage, gathering, field pressuring, reforming, petrochemical processing.

En-Tronic Controls—For automatic or semi-automatic sequencing of power or compressor machinery; for single compressor or complete systems with engine, motor or turbine drive. Complete systems are developed to include communication, instrumentation, telemetering and sequence control. Detailed analysis of your system by Cooper-Bessemer Application Engineers will show specific advantages in economy, operating dependability, safety and system flexibility.

HOW COOPER-BESSEMER SERVES YOUR NEEDS IN COMPRESSION FACILITIES

Cooper-Bessemer products are recognized the world over for their outstanding performance . . . their efficient operation, 'round-the-clock dependability and low maintenance. Whatever your needs in compression or power facilities, it will pay you to check Cooper-Bessemer when you start to plan. Call the nearest office.

BRANCH OFFICES: Grove City • New York • Washington Gloucester • Pittsburgh • Mount Vernon • Detroit • Chicago Minneapolis • St. Louis • Kansas City • Tulsa • New Orleans Shreveport • Houston • Greggton • Dallas • Odessa • Pampa Casper • Seattle • San Francisco • Los Angeles

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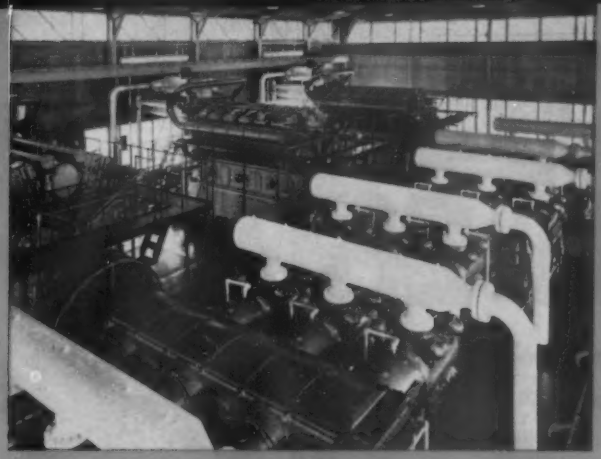
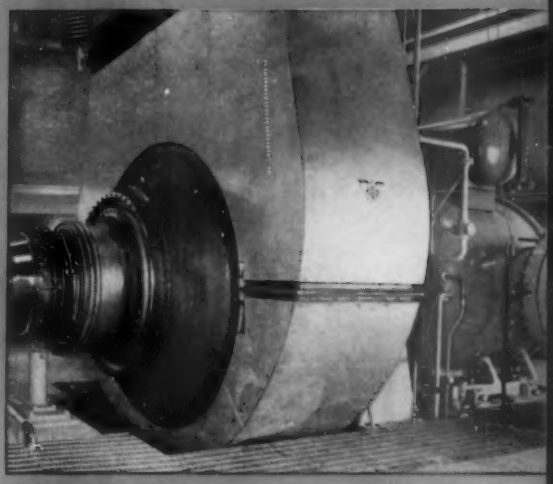
Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

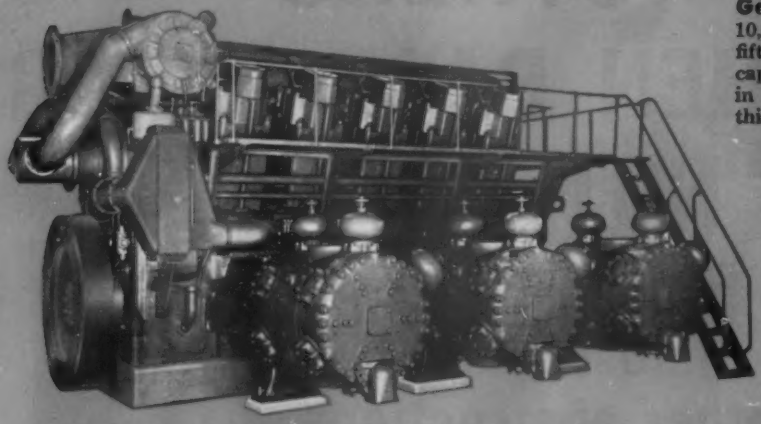
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINES: GAS - DIESEL - DUAL-FUEL
JET-POWERED GAS TURBINES



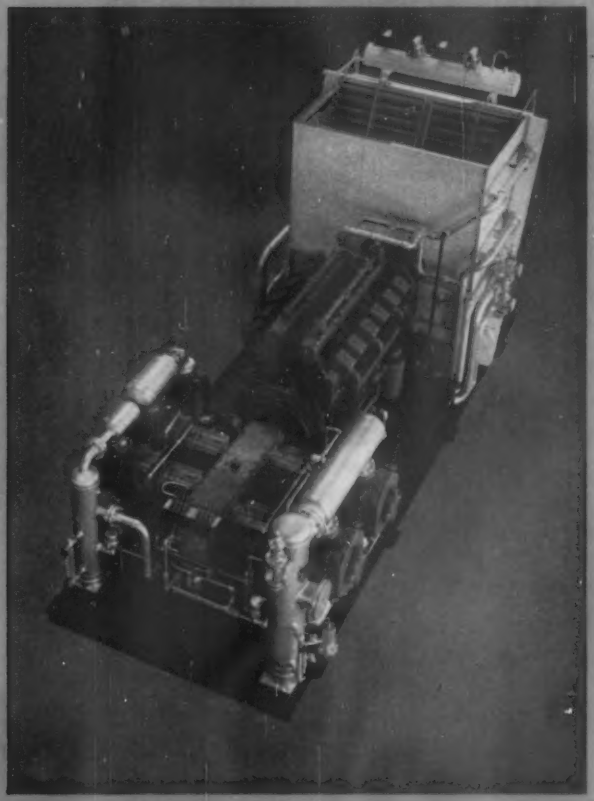
Compressors for Every Drive—100 hp to 10,000 hp Adaptable to engine, motor or turbine drive; horizontal reciprocating · Service: Gas processing, recycling, transmission, refinery, petrochemical and industrial or process air.

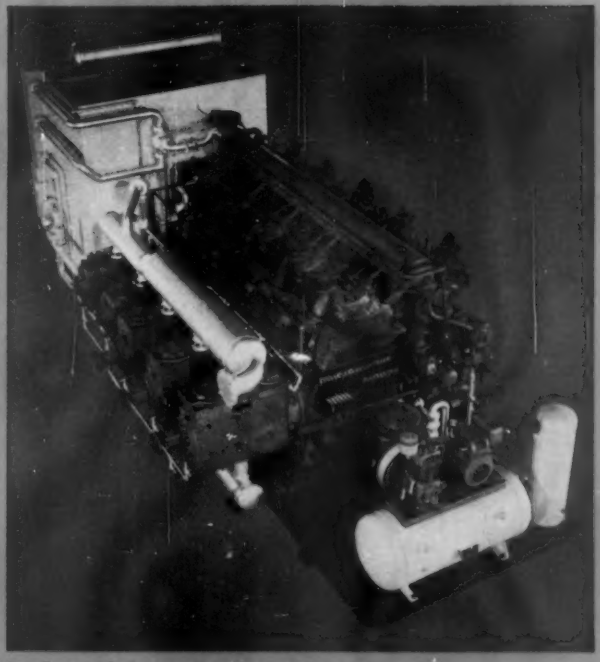


Gas Turbines—Cooper-Bessemer jet-powered 10,500 hp RT-248 gas turbine weighs less than one-fifth as much as conventional gas turbine of same capacity. It is shown driving main line gas booster in gas transmission. Write for further details on this and other C-B gas turbine units.



V-Angle Compressors—265 hp to 3500 hp · Gas engine compressor centrifugally aspirated, or series turbocharged · Service: Main line transmission, gas lift, storage, gasoline extraction, refrigeration, refinery and petrochemical processing · Shown above: Cooper-Bessemer Model GMWC Compressor.



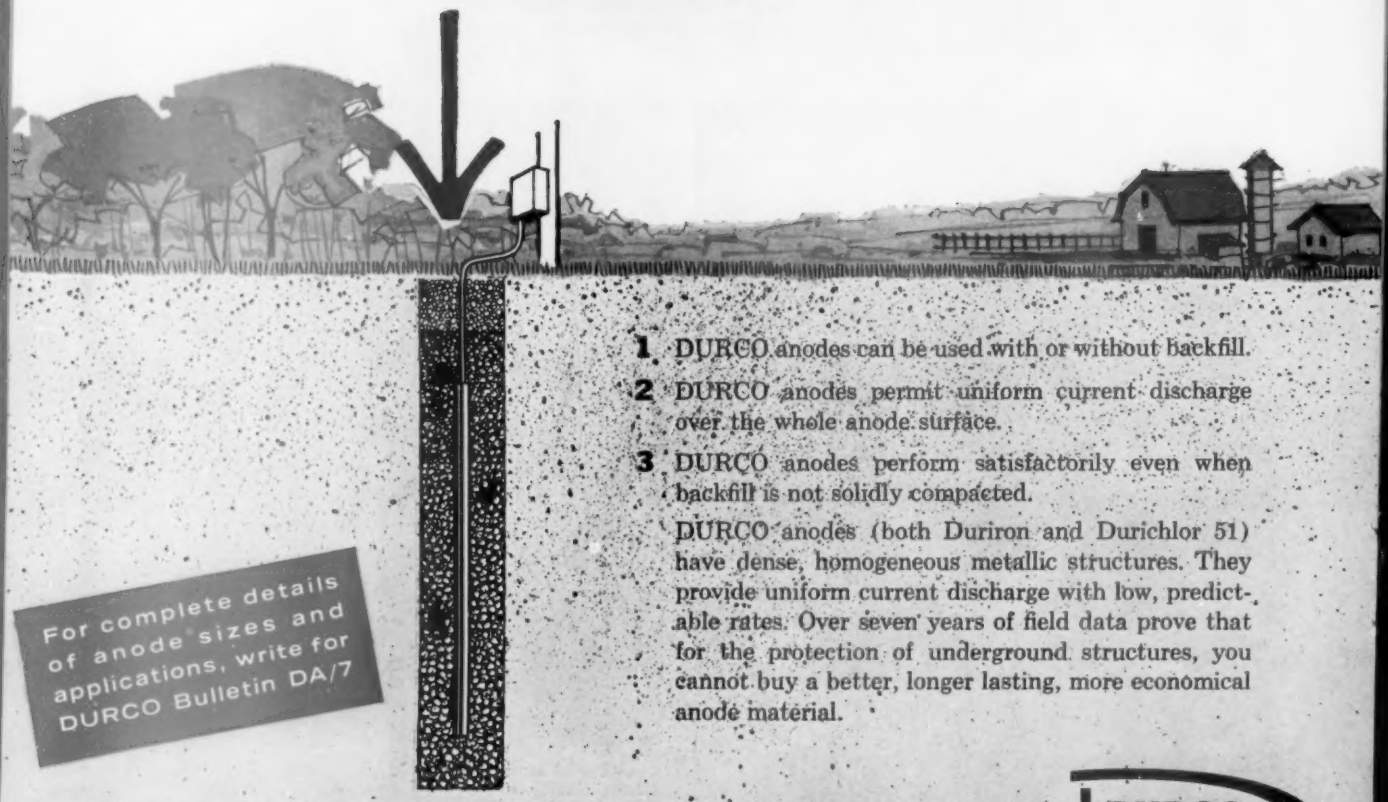


Packaged Compressors—100 hp to 1100 hp · Gas engine driven, completely packaged, prepiped and skidded, by C-B Southern · Service: Field-to-line booster, pressure maintenance, gas lift, repressuring, refinery processing, extraction, plant air.

Shown above: *(Left)* Cooper-Bessemer Model AM-4 unit. *(Right)* Cooper-Bessemer Model GMXD-10 integral V-angle unit.

DURIRON ANODES OUT-PERFORM ALL OTHERS WHEN BACKFILLING IS NOT PERFECT

due to poor compacting or the inclusion of clods, rocks, or other obstructions



1. DURCO anodes can be used with or without backfill.
2. DURCO anodes permit uniform current discharge over the whole anode surface.
3. DURCO anodes perform satisfactorily even when backfill is not solidly compacted.

DURCO anodes (both Duriron and Durichlor 51) have dense, homogeneous metallic structures. They provide uniform current discharge with low, predictable rates. Over seven years of field data prove that for the protection of underground structures, you cannot buy a better, longer lasting, more economical anode material.

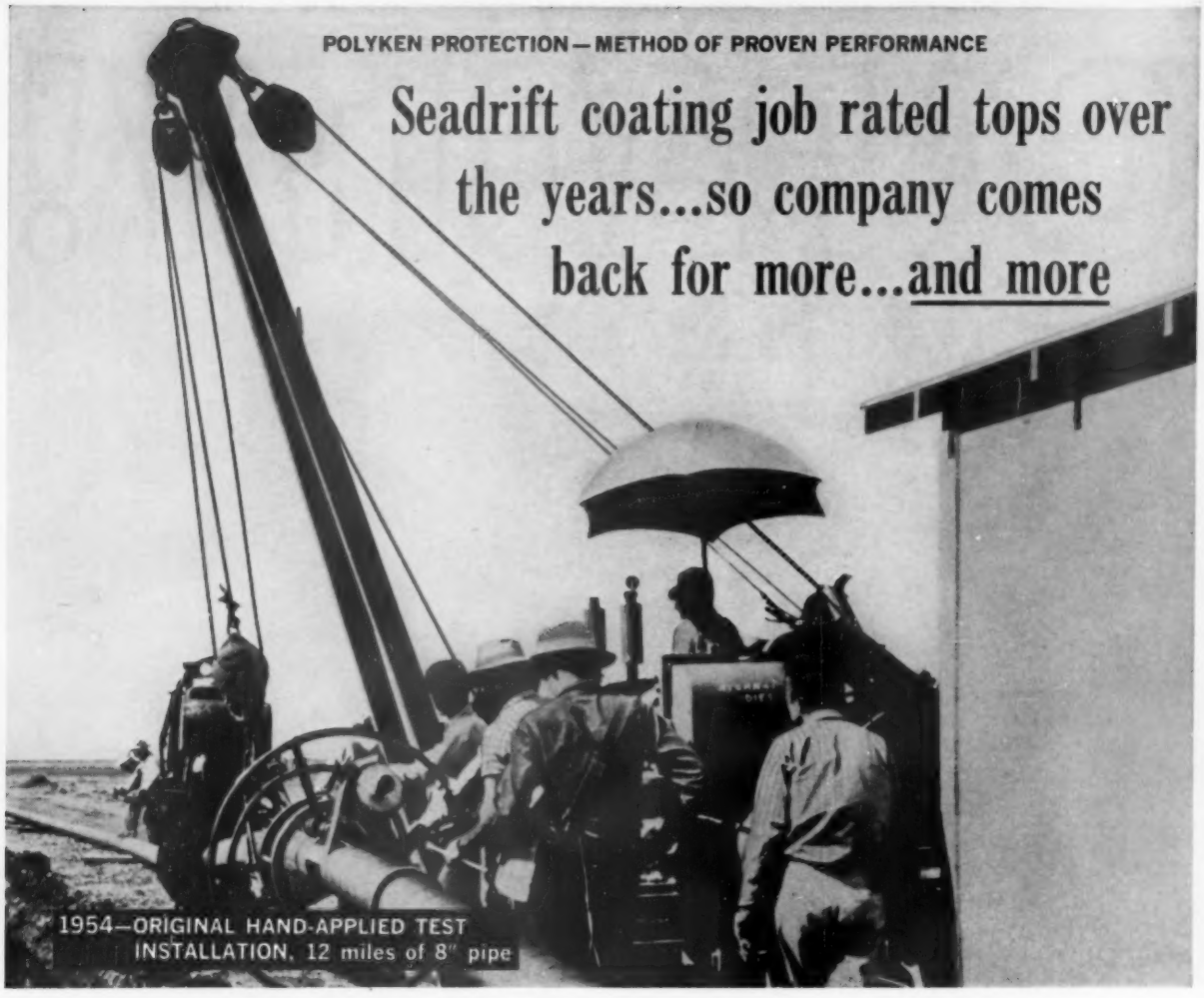
For complete details of anode sizes and applications, write for DURCO Bulletin DA/7

THE DURIRON COMPANY INC., DAYTON, OHIO

DURCO

POLYKEN PROTECTION—METHOD OF PROVEN PERFORMANCE

Seadrift coating job rated tops over the years...so company comes back for more...and more



1954—ORIGINAL HAND-APPLIED TEST INSTALLATION, 12 miles of 8″ pipe

1957—ANOTHER SEADRIFT INSTALLATION, 31 miles of 6″ pipe
1960—STILL ANOTHER SEADRIFT INSTALLATION, more than 300 miles of 6″ and 8″ pipe
1960—ANOTHER MAJOR PRODUCTS PIPELINE INSTALLATION, on 8″ pipe

Bell hole examination convinces second firm, too, to make important use of Polyken protection!

Proof of dependable performance . . . most graphic endorsement of Polyken. In 1954, Seadrift Pipeline Co. test-installed gas pipeline from Bee County to Seadrift, Texas, wrapped with Polyken #900 Black. Very satisfactory cathodic protection requirements on the line made Polyken tape the choice again on a job from Live Oak County to Seadrift in 1957.

In 1960, a bell hole examination of the original job showed Polyken tape still in top-rated condition after 6 years. No pipe rust or corrosion. No time-wear or deterioration of tape. So, fully convinced Seadrift officials put Polyken protection to work on their 1960 projects. And engineers from *another* major pipeline company, equally impressed, ordered this *proven performance* coating for an important part of their new products line in Iowa.

This kind of performance adds to the growing list of Polyken tape users some of America's most exacting firms. Get full details on Polyken performance and economy from your Polyken representative, or write Polyken Sales Division, 309 West Jackson Blvd., Chicago 6, Ill.

Polyken®

EXPERIENCED IN PROTECTIVE COATINGS

THE KENDALL COMPANY
Polyken Sales Division

For Further Information on Advertised Products See Reader Service Card

CAPACITY!

Look at that "320" hogging out trench on this 36" job for J.P. Neil & Company on the 1,200 mile Pacific Gas Transmission line.

DEPTH CAPACITY
WIDTH CAPACITY
CONVEYOR CAPACITY
PRODUCTION CAPACITY

you get 'em all in the CLEVELAND "320"

Get the latest dope on **PROVED** *Clevelands now*

CLEVELAND TRENCHER

THE CLEVELAND TRENCHER CO., 20100 ST. CLAIR AVE., CLEVELAND 17, OHIO

ARMCO THIN-WALL LINE PIPE IS BACKED BY 27 YEARS' EXPERIENCE

Steel For strength, economy, durability

Armco customers have been using thin-wall line pipe—and saving money—for years. Armco pioneered this development more than 27 years ago and has supplied the oil and gas industry with "thin-skinned" line pipe ever since.

Improved coating and cathodic protection methods eliminate the need for any corrosion allowance in the pipe wall and make it possible for you to select only the wall thickness necessary for your specific application. Armco makes this selection an easy one (and reduces your original line pipe cost) by providing the widest range of diameter-wall thickness combinations. You buy only the steel you need—no extra.

Let Armco's experience in supplying thin-wall pipe work for **you.** Mail the attached coupon, outlining your pressure requirements, and an Armco Sales Engineer will contact you promptly. Write to **Armco Drainage & Metal Products, Inc., subsidiary of Armco Steel Corporation, 202 KOME Building, Tulsa, Oklahoma.**

I want more information about Armco Line Pipe.

My requirement is_____

NAME_____

COMPANY_____

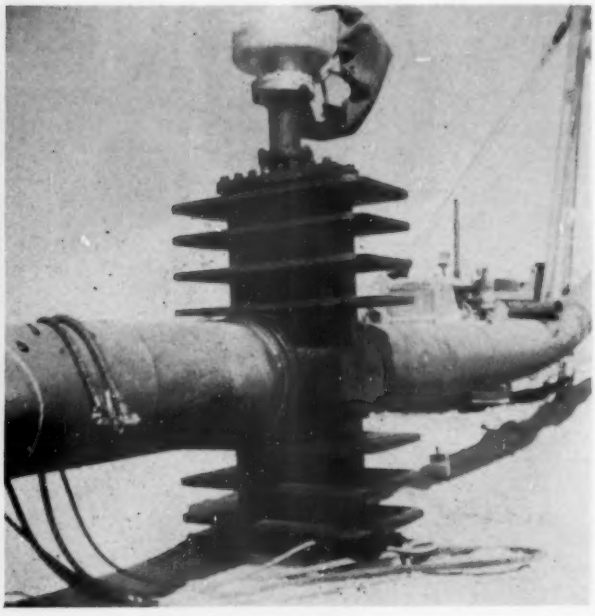
STREET_____

CITY_____ STATE_____

ARMCO Drainage & Metal Products

EL PASO NATURAL GAS COMPANY PROTECTS LINE VALVES WITH ROSKOTE COLD-APPLIED MASTIC

Roskote cold-applied mastic was spray-applied to 30" valves by El Paso Natural's personnel at Grants, New Mexico. Risers and support legs were coated with Roskote and wrapped with Royston Glas-Wrap for additional mechanical abrasion protection.



On the El Paso Natural Gas Company line being laid at Fort Stockton, Texas, by Western Pipeline Company, all 20" valves were spray-coated with Roskote cold-applied mastic.

You get superior protection against the most severe field corrosive agents with Roskote cold-applied mastic. Valves, risers, line pipe, tanks and other structures above or below ground are coated with Roskote by spray or brush without heat, flame or toxic and irritating effect on workers. The quick-drying feature of these mastics permits early backfilling. Roskote's time-saving, cost-saving application complements its low first cost to provide you with the most economical means of long-life metal protection.

Roskote is applied cold winter or summer. It retains its plasticity at 0°F., and will not run or sag at 250°F. Its high dielectric strength and resistivity, and its superior resistance to acids and alkalies provides ample protection even under the most rigorous underground or atmospheric corrosive conditions. Specific formulations are available for resistance to high crude oil concentrations and gasoline seepage in surrounding soil.

Royston engineers will give prompt attention to your inquiry.

ROYSTON LABORATORIES, Inc., P.O. BOX 112-N, PITTSBURGH 38, PA.

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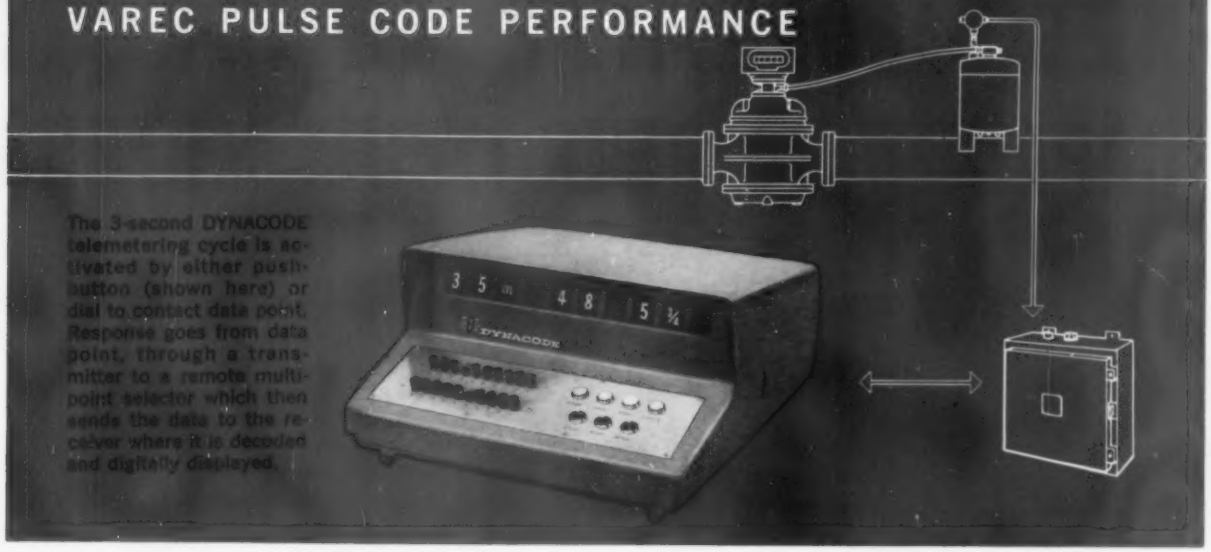
DYNEL DYNACODE TELEMETERING SYSTEM

A NEW HIGH-SPEED REMOTE MONITORING SYSTEM BASED ON 6 YEARS OF FIELD PROVEN VAREC PULSE CODE PERFORMANCE



The 3-second DYNACODE telemetering cycle is activated by either push-button (shown here) or dial to contact data point. Response goes from data point, through a transmitter to a remote multi-point selector which then sends the data to the receiver where it is decoded and digitally displayed.

Dynel engineers—utilizing the performance proved concepts of Varec's famous Pulse Code system—have developed the significantly advanced DYNACODE telemetering system for remote readings of liquid level, temperature and P.D.M.

This single-channel, "error-proof" system combines the proven reliability of the basic Varec system with a digital readout time of 3 seconds per point...readout accuracy of 1/16 inch...readout capacity of an unlimited number of points...and readout versatility that permits the system to be tied into a general purpose computer for inventory, billing, and similar functions.

Solid state components are used at key points in the receiver design for longer, maintenance-free life. And DYNACODE, like Varec's Pulse Code, has an instantaneous alarm system without scanning delays.

The high-speed DYNACODE System offers these advantages:

Reliability: Design based on 6 years of performance in scores of pipeline and refinery applications.

Data Display: Illuminated, in-line digital display includes point and function identification, digital data to 6 significant figures and liquid level to 1/16" increments.

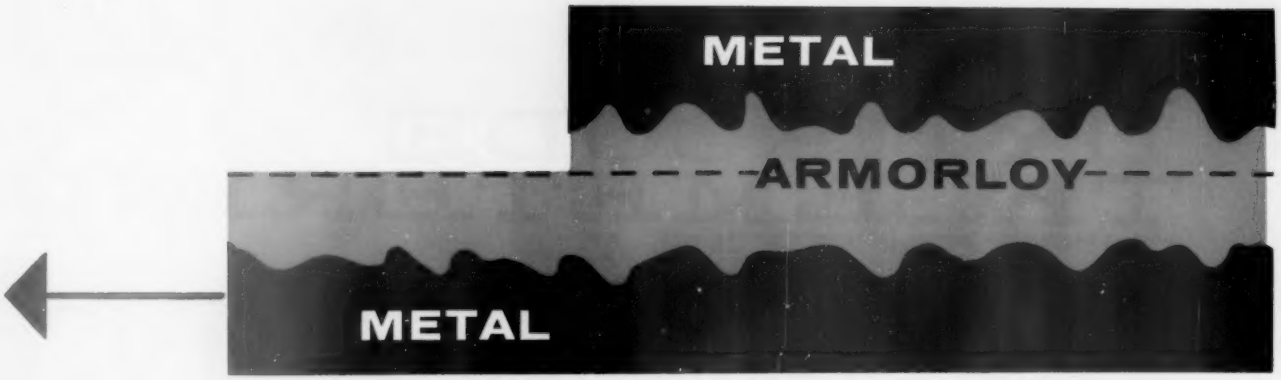
Fast Response: data from any given point is gathered and digitally displayed in just 3 seconds.

Flexibility: Designed on building block principle that permits a great variety of system arrangements...DYNACODE is compatible with all standard systems of measurement.

Readout Variety: digital output provides a variety of readouts, including visual display, paper tape, typewriter, etc. Output is compatible for use with general purpose computers.

For complete information, write for Bulletin 301, Dept. PTE-1600-3

DYNEL, Inc., *a subsidiary of Varec, Inc.*
12923 S. Spring Street, Los Angeles 61, California • Branches and Representatives in Principal Cities



NEW A. O. SMITH ARMORLOY CAPACITY TO PETROLEUM METERS

New solid film lubricant features exceptional corrosion resistance qualities

ARMORLOY — a new, unique lubricating film application is now standard on A. O. Smith petroleum meters. Armorloy is the same type of solid film lubricant which has been used with great success on jet and rocket engine applications.

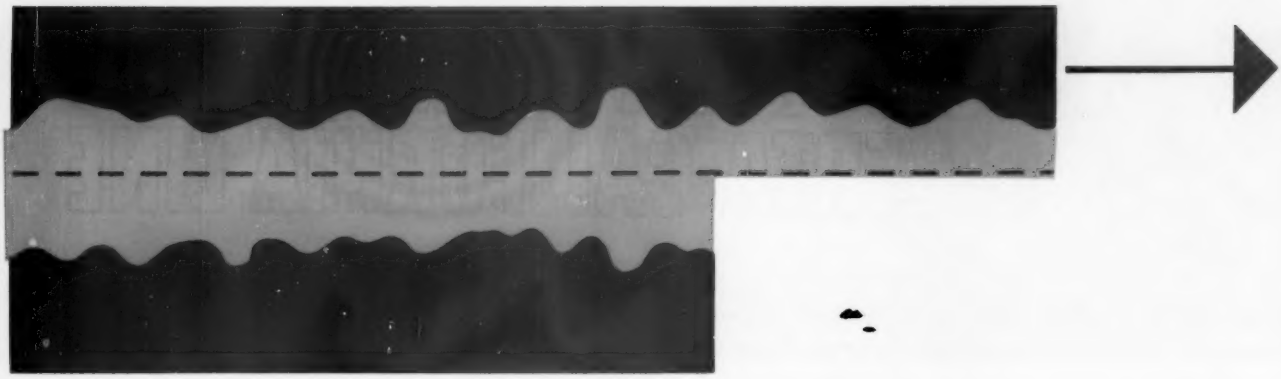
Tough as nails, the new A. O. Smith Armorloy process is especially valuable in fighting the normal corrosive action of some metered fluids. Armorloy also provides maximum protection against wear and friction for contact components because it greatly increases the self-lubricating ability of the meter.

You can't take it off without removing the basic metal — Armorloy is sprayed onto the metal surface of all internal metal components, then baked at 300 F for one-half hour. After this scientifically controlled thermosetting, Armorloy is on to stay.

Thanks to the introduction of Armorloy — plus important additional changes — A. O. Smith is also proud to announce the *new capacity ratings* for its complete line of line and high pressure meters.

Armorloy is just another step in A. O. Smith's far-reaching design program to make petroleum meters serve your industry better!

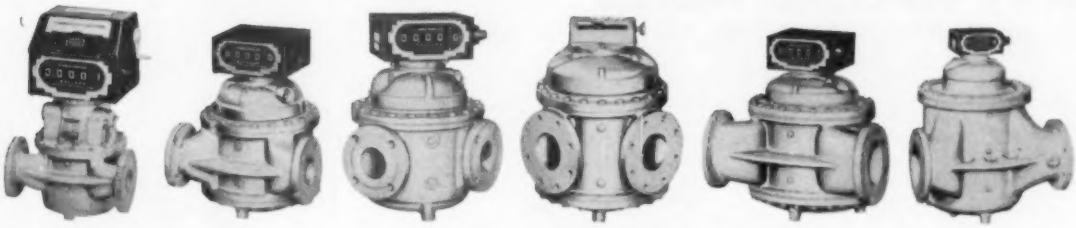
SEND FOR ARMORLOY SAMPLES! Rub them together, feel — and test — Armorloy's outstanding lubricated surface. Simply fill out the coupon and mail.



PROCESS ADDS LIFE AND EXTRA AT NO EXTRA COST TO YOU!

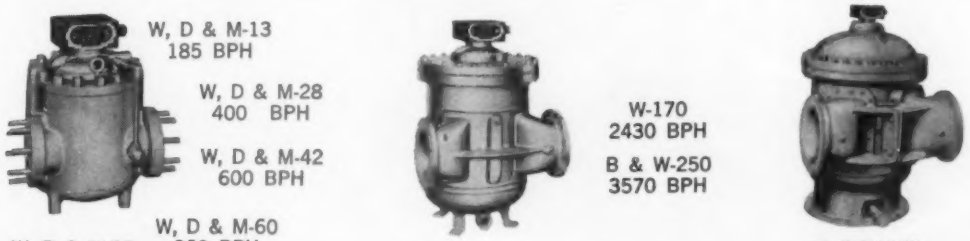
New Armorloy process helps increase meter capacity as much as 25%

LINE METERS



S & B-13 130 GPM | S-28 280 GPM | S, AS & AB-42 420 GPM | S, AS & AB-60 600 GPM | S & AB-100 1000 GPM | B-170 1700 GPM

HIGH PRESSURE METERS



W, D & M-13 185 BPH
W, D & M-28 400 BPH
W, D & M-42 600 BPH
W, D & M-60 860 BPH
W, D & M-90 1285 BPH
W-170 2430 BPH
B & W-250 3570 BPH
B & W-875 12500 BPH

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62 GROVE G-4 MAINLINE VALVES IN THE ALBERTA-CALIFORNIA LINE

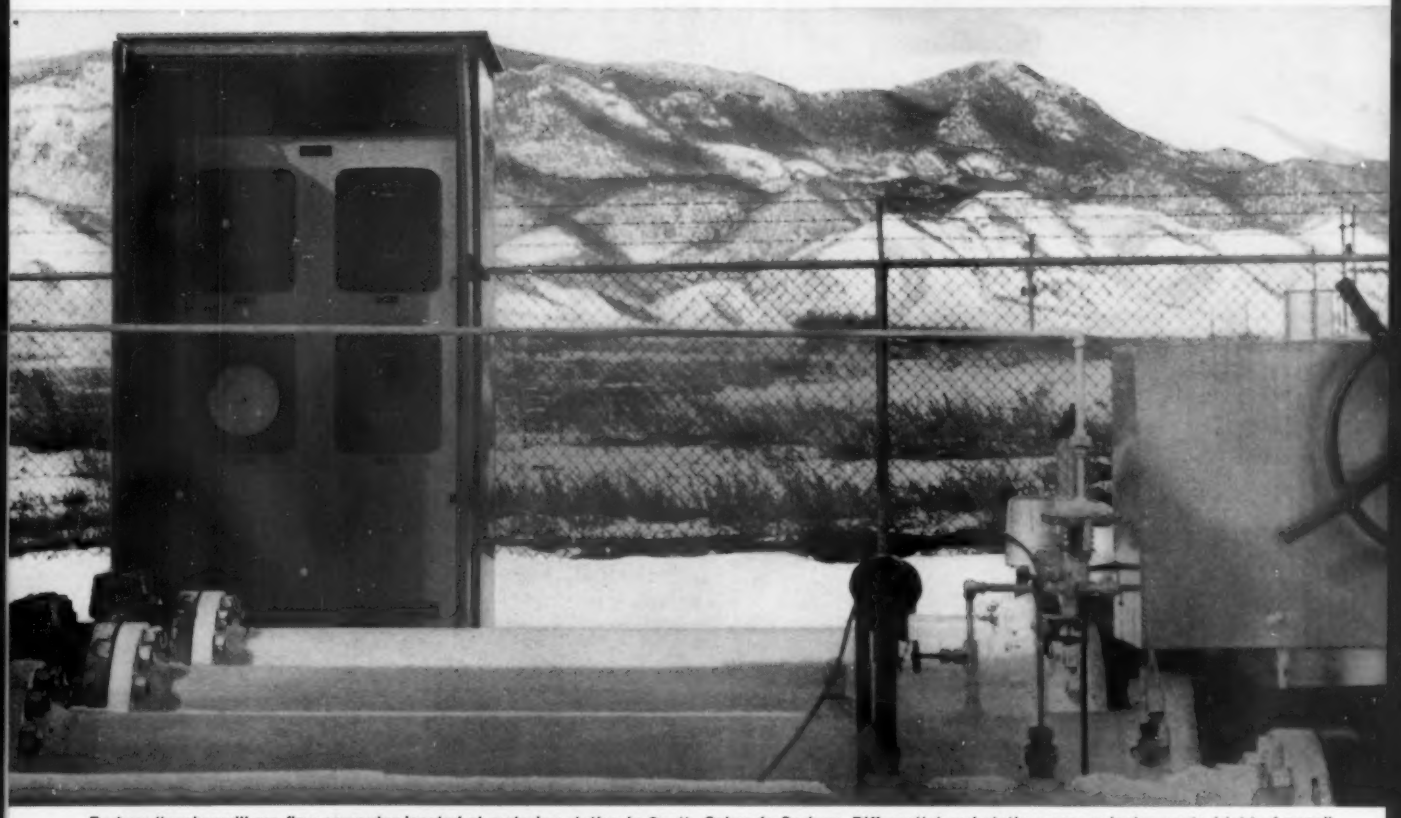
Throughout the 1,018 miles of its 36″ section, the new Alberta to California natural gas pipeline uses Grove Series G-4 mainline valves. These valves are among the largest full-opening mainline valves ever put in service. They feature the field proven patented Grove Seal-"O"-Ring® design, with its "double-barrier seal." A positive, primary metal-to-metal seal is backed up by the squeegee and sealing action of protected o-rings, to assure a bubble-tight seal, easy open and close. Because G-4 valves do not rely on sealing compounds, they completely eliminate all maintenance costs relative to lubrication.
Call your nearest Grove office and learn how Grove pipeline valves can serve and save for you in your next pipeline.

GROVE PIPELINE VALVES

GROVE VALVE AND REGULATOR COMPANY
a subsidiary of Walworth
6529 Hollis Street, Oakland 8, California
Offices throughout the U. S. and in Western Canada

7168

This Colorado Interstate Dispatcher is reading gas flow data from four different states...



Foxboro "packaged" gas flow computer located at metering station in South Colorado Springs. Differential and static pressure instruments (right of panel) convert measurements to electrical inputs for the Dynalog* Computer-Telemeter (lower left). Instrument at upper left telemeters down-stream gas pressure.

Foxboro Gas Flow Computing Systems deliver it continuously, automatically

Continuous gas flow totals from 20 metering stations, scattered across four Rocky Mountain states. That's the information Foxboro Gas Flow Computers provide for Colorado Interstate Gas Company in Colorado Springs.

Foxboro Gas Flow Computers do their computing at the metering point. Compensation for temperature and pressure is done on the spot with only total gas flow values being transmitted. Result: transmission line space is saved; errors common to systems that transmit several values are reduced.

Foxboro Gas Flow Computers are furnished as a complete "packaged" unit — calibrated and tested as a system before shipment — ready to install.

For single meter runs — for multiple runs, you can't beat the accuracy or the reliability of this Foxboro system. Ask your local Foxboro Field Engineer for details.

The Foxboro Company, 3811 Norfolk Street, Foxboro, Massachusetts. **Reg. U. S. Pat. Off.*

FOXBORO

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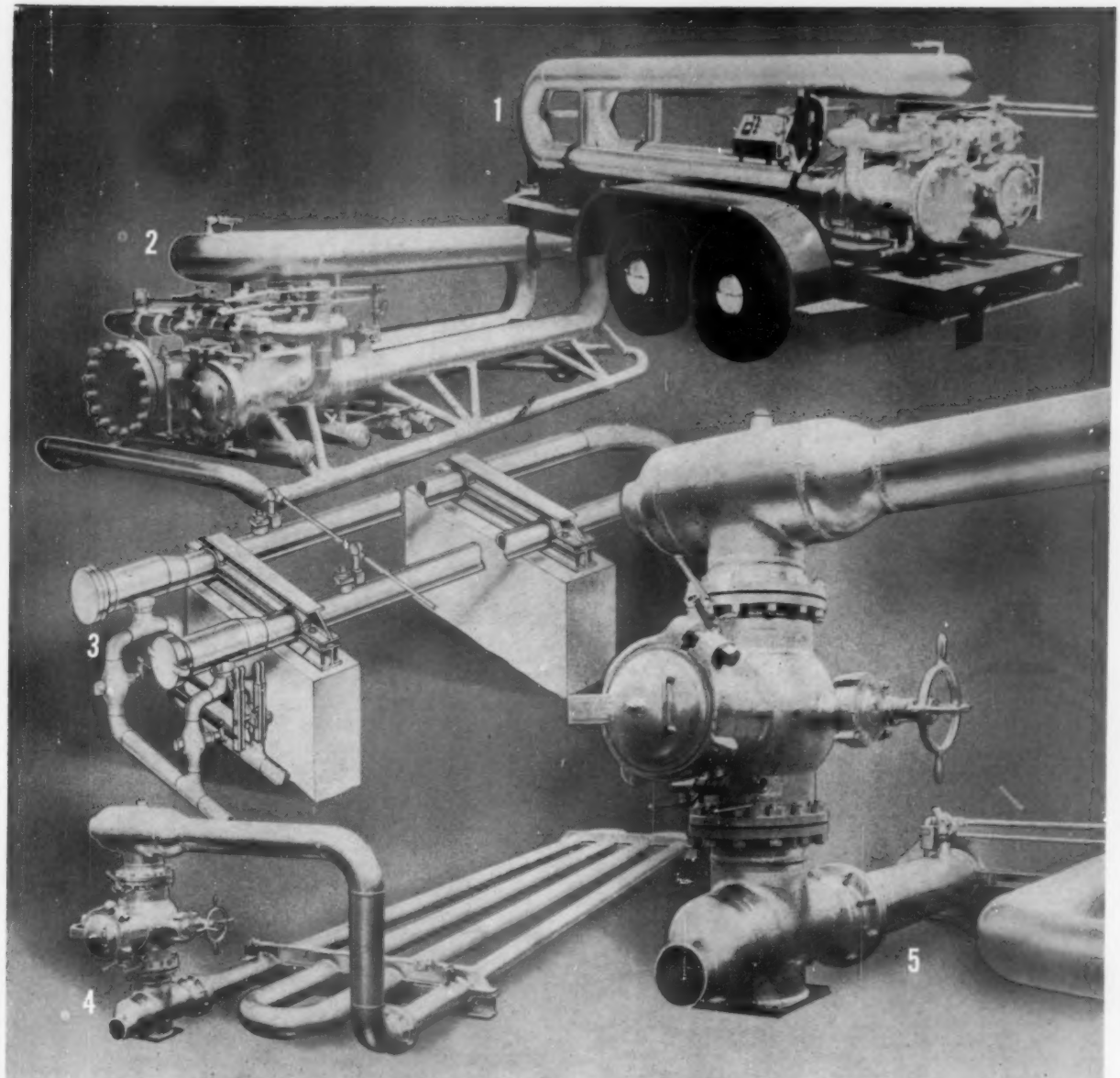

NOW ACCURATE, DEPENDABLE METER PROVING — Maloney's **new** precision built provers now make perfected meter proving practical on virtually all liquid-carrying lines. Constructed of high quality materials, Maloney unidirectional and bi-directional provers are fabricated under constant engineering supervision. Illustrated units are:

1. **Bi-directional trailer-mounted**
2. **Bi-directional skid-mounted**
3. **Bi-directional U-Bend**
4. **Unidirectional, interchange and loop**
5. **Unidirectional, interchange only**

The units illustrated are standard models. However, larger units may be specially engineered to fit a customer's particular need. For additional information on all Maloney meter provers, please write the Company's Houston office for Bulletins MP-1 and MP-2.

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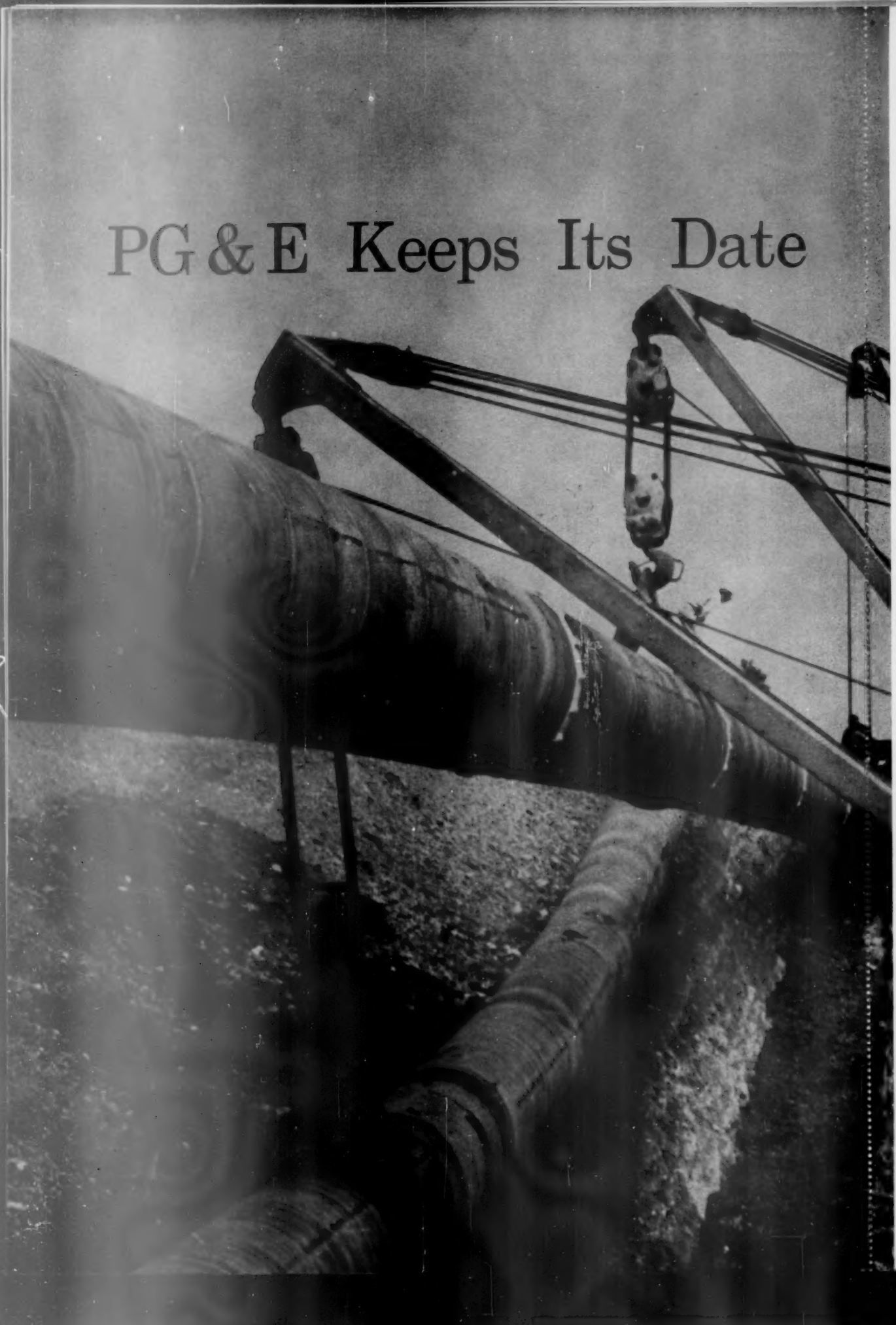
PG&E Keeps Its Date



With D-Day

Marking the Alberta-California gas pipeline as the year's biggest project are the startling statistics it has racked up. Imagine the magnitude of a construction project that has involved:

137 government agencies
17,000 acres of right-of-way (and 1900 negotiations)
500,000 tons of steel, (and 16,800 railway cars)
325 miles of circumferential welds

In a scant year's time:

13,000,000 cu yd of right-of-way have been excavated
12,000,000 cu yd of ditch have been excavated
180 miles of 5 ft by 7 ft rock ditch have been blasted
185,000 joints of 36-in. pipe have been welded.

As many as 4400 men have worked at peak of construction on this project which involves almost 1600 miles of pipe.

Before the end of the year the Alberta-California pipeline will begin delivering 415,000,000 cu ft of natural gas a day to Central and Northern California, an area that has passed the 6,500,000 population mark and is increasing at the rate of 250,000 persons a year. Distribution of this huge volume of gas from producing fields of Alberta, Canada, will be by Pacific Gas & Electric Co. It will augment by 20% that company's present supplies received from California and Southwest wells.

Before deliveries are made at the California-Oregon border for California consumption, 140,000,000 cu ft a day will be turned into the transmission system of El Paso Natural Gas Co. and 30,000,000 cu ft delivered to Canadian-Montana Pipe Line Co., bringing daily average deliveries of the new pipeline to 585,000,000 cu ft a day. Later granting of additional export permits by Canadian authorities and with the construction of additional compressor stations, this can be increased to more than 800,000,000 cu ft a day to PG&E and 300,000,000 cu ft to El Paso Natural.

Participating Companies

There are five participating companies and three associated companies in the project.

Alberta & Southern Gas Co. Ltd., wholly-owned Canadian subsidiary of Pacific Gas & Electric Co., does not own any facilities but purchases gas from Alberta producers. This gas will be moved to the British Columbia border through the 573-mile Alberta portion of the system owned by Alberta Gas Trunk Line Co. Ltd., an independent company owned and controlled principally by the investing public resident in Alberta.

Alberta Natural Gas Co. will move the gas through British Columbia for a distance of 107 miles and deliver it to Pacific Gas Transmission Co. at the U. S. border. Alberta Natural is owned one-third by Pacific Gas Transmission, one-third by Westcoast Transmission Co. and one-third by the public.

Pacific Gas Transmission Co. will take the gas at the U. S.-Canadian boundary and transport it 611 miles through the states of Idaho, Washington and Oregon, delivering it to Pacific Gas & Electric at the Oregon-California border. It will also transport gas for El Paso Natural Gas Co. for delivery in the Pacific Northwest. PGT is owned 50% by PG&E, 25% by the other sponsors of the project, and 25% by the public.

Pacific Gas & Electric, principal sponsor of the system, will own and operate the final 296 miles of line in California terminating at Antioch and will market the gas through its existing transmission and distribution systems in Northern and Central California.

Other companies associated with the project are Westcoast Transmission Co. Ltd., El Paso Natural Gas Co. and Canadian-Montana Pipe Line Co.

By authorization of the Canadian National Energy Board, Westcoast can export to El Paso Natural up to 152,000,000 cu ft of gas a day. This gas will be carried by Alberta Gas Trunk Line and Alberta Natural Gas to the international boundary, from which point Pacific Gas Transmission will serve as the carrier to deliver to El Paso at Spokane and other points in Idaho, Washington and Oregon.

The National Energy Board also has authorized Canadian-Montana Pipe Line Co., subsidiary of The Montana Power Co., to export up to 36,000,000 cu ft a day. Alberta Gas Trunk Line will deliver the gas at Carway, Alta., near the international boundary through a 64-mile, 16-in. lateral.

Engineering-management services were provided individual clients who will operate the various sections of the pipeline from Alberta producing fields to the California-Oregon border by Bechtel Corp., in the U. S. Pacific Northwest and by Canadian Bechtel Ltd. in Canada. Pacific Gas & Electric Co. supervised construction of the California portion of the project.

Pipe Mileage, Specifications

The main line totals 1364 miles of pipe, all 36-in., except for 125 miles of 30-in. pipe. Of this, 910 miles are in the U. S. and 458 miles in Canada. Laterals, principally 16, 20, 22 in. in diam., bring the overall total to 1589 miles.

Pipe for the 36-in. main line is grade API

5LX-52, with 52,000 psi minimum yield, 0.438 in. wall thickness; 911 psi maximum operating allowable. Other pipe for specific conditions have wall thicknesses of 0.453, 0.469, 0.500, 0.531, 0.563, 0.625, and 0.656 in.

The Route

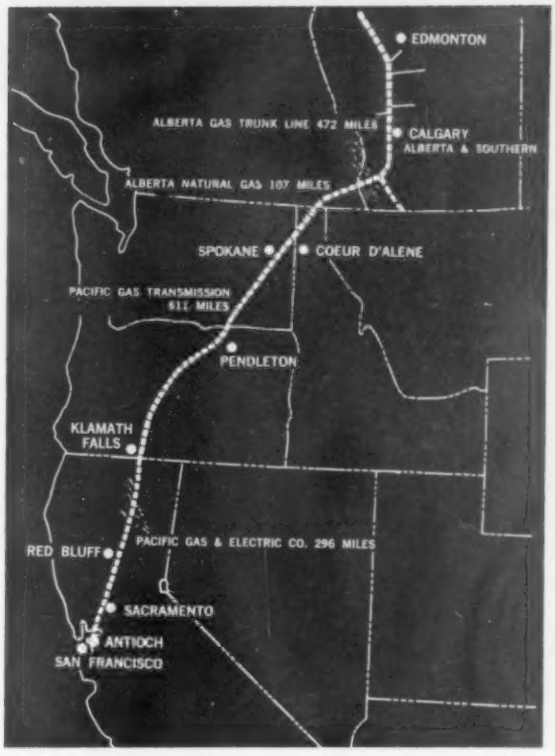
The pipeline originates in the eastern foothills of the Rocky Mountains, 125 miles northwest of Edmonton, Alta. It extends southward through Alberta, crosses the southeast corner of British Columbia, traverses the Idaho Panhandle, then through the southeast corner of Washington, Central Oregon and Northern California to Antioch, on San Francisco Bay.

Construction crews faced altitudes ranging from 7000 ft at Flathead Ridge, B. C., to 43.5 ft below sea level at the bottom of the San Joaquin River near Antioch, Calif. They crossed mountains, forests, canyons, deserts, irrigated farmland, rangeland, lava beds, as well as major and minor rivers. They worked in country where temperatures have been recorded as high as +117 F (at Umatilla, Ore.,) to as low as –50 F (at Red Deer, Alta.).

Despite these vicissitudes, construction time was exceptionally fast. Construction, some phases of which began in October 1960, reached a peak in June of this year when some 4400 men were on the job. Completion was in November. During the winter months large quantities of pipe were double-jointed, wrapped and coated internally; about 500 miles of right-of-way were cleared and graded; much blasting was done through lava beds and other rocky terrain; several river crossings were installed and some of the main line laid. This preliminary work permitted spreads to get off to a fast start in the spring. Only in a few areas did heavy rains, mud and flood waters interfere.

Construction Methods

Several factors highlighted design and construction procedures. Noteworthy was the internal coating with epoxy resin of 940 miles of 36-in. pipe . . . from the Alberta-British Columbia boundary to a point about 70 miles north of Antioch . . . to improve flow efficiency by reducing the friction factor and to minimize corrosion. The decision was based on available information from other companies' experience with internal coating and on PG&E's own experience with its 34-in. Topock-Milpitas "Super Inch" line. From experience with the latter, a friction factor of 0.0023 was selected for the Alberta-California system, and it was concluded that the coating reasonably could be expected to reduce this factor to 0.00205 at a flow rate of 800,000,000 cu ft a day. This would result in a savings of approximately 28,000 compressor hp, a capital savings of $7,000,000. Estimated cost of the internal coating in place was approximately $1,500,000. The epoxy resin was applied to thickness of 2½ mils at the three pipe mills and at some of the field yards where pipe was double-jointed and wrapped.



Route of the Alberta-California gas pipeline, biggest project of the year.

All pipe was coated externally. On the Alberta Natural Gas and PGT sections pipe was given a double wrap and single coat of 3/16-in. thick asphalt enamel, unsaturated glass and felt wrap. More corrosive areas demanded two coats of asphalt enamel, saturated glass and felt wrap to increase the thickness.

In California, due to a favorable bid, Somastic coating was used on the entire 296-mile section. Application was to a thickness of ⅝-in. All river crossings were Somastic-coated, too, with concrete added to provide the proper negative buoyancy. Most of the Somastic was applied at H. C. Price Co. plants at Burney and Napa, Calif. Approximately 50,000 ft of twin 26-in. pipe that went into the crossings of San Joaquin and Sacramento rivers and Sherman Island in the San Francisco Bay area were Somastic-coated at the Milpitas, Calif. plant of Pipe Linings, Inc., then cement-mortar coated at the Hayward plant of American Pipe & Con-

Barge-mounted winches, helped by sideboom tractors and bulldozers, pull Kootenai River crossing.

struction Co., parent company of Pipe Linings.

The 296 miles of Somastic-coated pipe in California is the longest overland section of pipe so coated. The 5/8-in. coating added 66.7 lb per ft to the pipe, bringing its weight to slightly over 231 lb per ft. With an 80-ft double-jointed length thus weighing 18,500 lb, only two lengths per truck could be hauled.

All pipe in the system was double-jointed into 80-ft lengths and coated in yards, principally at railheads. Welding was automatic, for the most part requiring pipe rotation.

While the job was in progress, however, development of the Price-Crose-Perrault automatic position welding machine reached a stage where it could be used on a part of the California section and on the Price-Poole spread in British Columbia.

Manual field welding used E-6010 electrodes for the stringer bead, E-7010 for the hot pass and filler passes, and either E-7010 or E-6010 for the cover pass. Welds were inspected by radiography.

Many Problems

Rock, extremely difficult canyons and numerous major rivers presented their share of construction problems. An estimated 180 miles of solid rock ditch had to be blasted, as well as areas where rock was found intermittently below the surface from which the soil was stripped before shooting. Quadruple and twin drills mounted on sideboom tractors bored holes 36-in. apart on both sides of the the 48-in. trench. Three sticks of 40% dynamite, plus war surplus TNT flakes, were put into each hole and then earth was tamped in as a cover. Two workmen, one on each side of the trench, ignited the 10-ft fuses, and a trench normally about 500 ft long was blasted with one set of charges. Because the fuses were slow-burning, the men had some 10 min to light them and find cover.

Considerable lava rock, because it was porous and seamy, gave unpredictable results when shot and charges often were sucked into the earth and lost, or blown out of the shot hole. Often the discharge came out some distance from the ditch line. In some areas shots had to be made as many as three times. This type of formation was encountered in California by H. C. Price Co. and in Oregon by Western Pipe Line Inc., part of the Western-Neill joint venture. Western had some 50 miles of lava ditch on one of its schedules in the northern part of Oregon — a 157-mile schedule which, incidentally, probably set a record because 85% of it was shoot rock.

On Western's other schedule through Southern Oregon an unusual sponge-like pumice was encountered. For a distance of 40 to 50 miles through this formation, it was difficult to keep the ditch from sloughing. Extreme slopers on the ditching machines solved the problem.

An outstanding example of difficult terrain was the John Day Canyon in Oregon, also on the Western spread. Here the pipeline drops 3000 ft from the cliff to the bottom of the canyon, parallels the canyon walls for 10 miles, then rises 3000 ft to emerge from the canyon. The grade into and from the canyon is 33-45 deg. Equipment working on the grades had to be held by winch tractors, usually three for each piece of equipment. Welding was at trench-

Pipe yard of H. C. Price Co. at Burney, Calif., one of the points where pipe was coated with Somastic.

side. Because of inaccessibility, a helicopter and airplane were on duty at all times, to air-drop parts into the canyon.

The John Day River, which flows mid-point between the canyon walls, had to be crossed with the pipeline. It was necessary to use flexible floats to ferry equipment across it for other phases of the canyon work.

Underground water was found for a distance of six miles through the canyon floor. To divert it back to its natural flow in the river, sacks of dirt were used to pad the bottom of the trench and sack breakers were placed on top of the pipe every 30 ft.

Juniper Canyon, near Wallula, Wash., on the J. P. Neill & Co. spread, is 800 ft deep, with a south slope of 35 deg and a north slope not quite so steep. Rock had to be shot all the way through, and every piece of equipment had to be winched in and out. Rock drills were hung off winch lines to make shot holes. Due to steepness of the grade which caused the rock to roll to the bottom of the canyon when removed from the trench, customary methods had to be abandoned. A small front-end loader working from the top scooped the rock and started it on its downward roll.

Pipe was welded on, an 80-ft section at a time, from the top down on the south side and from the bottom up on the north side. Distance across the canyon is 1700 ft.

U. S. River Crossings

Major river crossings were made by special contract, minor crossings by main line contractors. Most of them are single 36-in., 0.531-

Tough spot was John Day Canyon. Pipeline drops 3000 ft from top of cliff to bottom of canyon with 33-45 deg. grade.

Main line gate valves were set every 15 miles. This valve assembly weighs 40,000 lb, is 20 ft tall.

Moyie River was crossed 13 times in eight pipeline miles in Idaho and British Columbia. This is one of them.

in. wall buried lines. Most major crossings were coated with 5/8-in. Somastic plus sufficient concrete to provide 10% negative buoyancy. All underwater lines were pulled.

An unusual 4½-mile installation at the extreme northeast arm of San Francisco Bay involved crossing the San Joaquin and Sacramento rivers, as well as Sherman Island which lies at a junction between the two rivers. Ocean-going vessels navigating both rivers added to the problem of laying the lines.

These rivers and islands were crossed with dual 26-in. lines laid 7 ft apart in the same trench. The pipe, with a 0.438-in. wall thickness, was given a 5/8-in. Somastic coating plus 2¼-in. of concrete. Width of the San Joaquin crossing is 4000 ft levee-to-levee, the Sacramento 3100 ft and Sherman Island 15,000 ft. Both river crossings were given a 6-ft cover, placing the Sacramento line 41 ft and the San Joaquin 47 ft below mean low tide.

The Sacramento River pipe was made up in five 600-ft sections. The San Joaquin was made up in only two strings as there was enough bank area to provide working room. With pontoons attached every 120 ft, pipe was pulled. After a diver checked the ditch, pontoons were released and the pipe settled into place.

Sherman Island is largely peat land in which are grown vegetables and farm crops. High water level had to be continuously pumped from the 20-ft wide trench while 720-ft sections of pipe were pulled into place, tie-in welded and given 6 to 7-ft cover.

In the second widest crossing — the Pend Oreille River southwest of Sandpoint, Idaho, where normally water is 80 ft deep — 2300 ft of pipe were laid in winter during lower water level.

The swift, steep-embanked Snake River near Starbuck, Wash. was crossed in summertime low water with 1700 ft of pipe. The bottom rock had to be shot. As the river is a short distance above the confluence with the Columbia River and in good fishing country, particular regard was given fish life.

The Kootenai River, near Bonners Ferry, Idaho, like the Pend Oreille was crossed last winter to take advantage of low water. Work had to be fast, however, because the winter was warmer than usual, and the thaw came earlier. The line was pulled in one section. A railroad runs close to the south bank, so a sharp bend was made on the end of the river pipe to make it fit into the casing installed beneath the tracks. This was a 1000-ft single 36-in. line with Somastic applied to 7/8-in. thickness and concrete added.

Near Red Bluff, Calif., the Sacramento River was crossed at a point that is 1700 ft wide with dual lines, 26-in., because of strong current and large volume of water controlled by Shasta Dam. The river bed was shot and dredged, and the line was pulled in sections.

The general practice of burying river crossings was not followed at Battle Creek and Pit River. Battle Creek, a tributary of the Sacramento River about 31 miles northeast of Red Bluff, is shallow but flows through a steep 140-ft deep rock canyon. An unsupported 140-ft span of bare 36-in., 0.625-in. wall pipe was laid across the canyon. The Pit River crossing near Burney, Calif., was carried on four 20-ft pillars of an abandoned highway bridge after the pilings had been reinforced.

Numerous minor rivers were crossed with single 36-in. lines double-coated with asphalt enamel, inner wrap of glass and felt outer

wrap. In some instances pipe was gunnited, to provide necessary weight, and in others river clamps were used.

Minor, but highly unusual, was the Moyie River crossing. Partly in Idaho and partly in British Columbia, this circuitous stream was crossed 13 times — five in B.C. and eight times within a pipeline distance of eight miles in Idaho.

Canadian Program

Utmost coordination between all groups resulted in completion of Canadian segments by the scheduled November date.

In Alberta, principal construction was carried out by Alberta Gas Trunk Line, and contracts were awarded before the end of September 1960 for the main transmission line of Trunk Line's Foothills system and important laterals. These included 226 miles of 36-in., 125 miles of 30-in., 58 miles of 22-in., and 64 miles of 16-in.

Concurrently the contract was awarded for construction of the 107 miles of 36-in. line making up the Alberta Natural Gas Co. project across Southeastern B. C. — the essential link between Alberta and the United States.

Main contracts, started at the beginning of October, made history because they were carried on, at least in part, right through the winter, establishing for the first time in Canadian pipelining a year-'round work schedule of more than 12 months' continuous operations.

Canadian Bechtel Ltd.'s responsibilities as engineer-manager for Alberta Gas Trunk Line included engineering, management of procurement and inspection and supervision of construction of the Alberta project. The company performed the same function for Alberta Natural in British Columbia.

The only lateral in the Foothills system not owned by Alberta Gas Trunk Line is the one built by Saratoga Processing Co. Ltd. from the Savanna Creek field in Southwestern Alberta to the new processing plant at Coleman near the Alberta-B. C. border. Contract for this 44-mile, 16-in. was awarded to Banister Construction Co. Ltd.

After completion of the main Foothills transmission system, Alberta Trunk awarded contracts for four laterals totalling 21.3 miles of 16-in., 24.3 miles of 22-in., and 12.5 miles of 12-in. to connect processing plants.

The entire group was awarded to Henuset Brothers Ltd. Completion was scheduled concurrent with the November deadline for initial deliveries of gas through the Foothills system.

Geography was excellent for the general pattern of Alberta Trunk's program which was to establish a transmission system separate from its Plains division and to allocate the Foothills division to the carrying of gas for the export market. Wet gas fields supplying the export contracts are strung out along a narrow axis parallel to the Continental Divide between the eastern edge of the Foothills and the front range of the Rocky Mountains, which permitted advantageous and economical telescoping of the Foothills division from the 30-in. main line in the northern sector to the 36-in. line in the southern sector. There is ample reserve capacity for the addition of other fields by new laterals in the near future. The line also can be looped economically as export load builds up, an eventuality which is expected to be only a few years away.

Construction Features

The ability of all spreads to work straight through the winter on practically all parts of the job was the most distinctive major construction feature. Right-of-way clearing and grading were largely finished by spring. Riprap over muskegs and swamps was laid as far as possible during winter when ground was frozen and access easy. Most pipe on all sections was double-jointed in mobile yards moving along the right-of-way. Very little interruption to welding was caused by weather. Some ditch was cut in winter, as an experiment, with both rotary ditchers and backhoes. All but a few miles of pipe were strung from double-jointing yards or stockpiles as winter work progressed, minimizing truck damage to the right-of-way during the spring thaw.

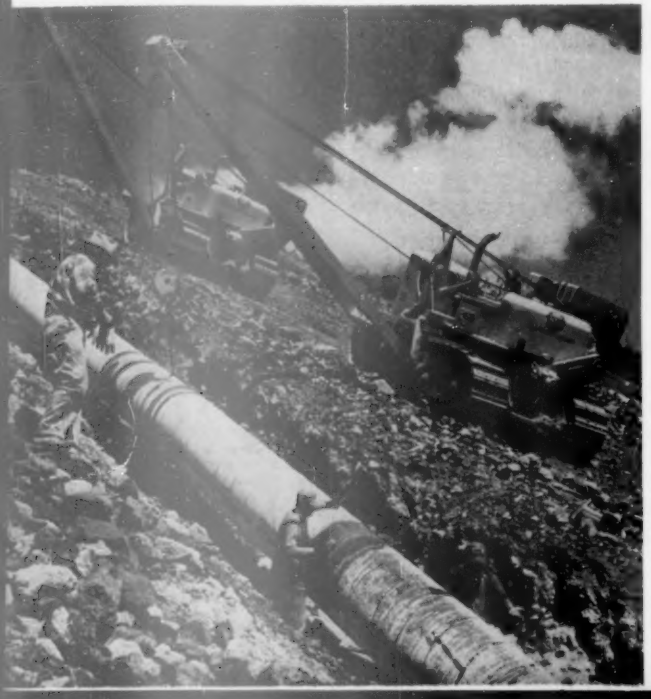
One of the outstanding construction features was the fully automatic double-jointing of most pipe on all sections. Crose-Price-O-Matic equipment, the first to be used on a Canadian job, did most of the welding. The yard, operated by Dutton-Williams Brothers Ltd. started in the middle of November turning out 30-in. double-jointed pipe at the maximum rate of 157 welds per day during the short working days of the northern Canadian mid-winter season. Average production was in excess of 100 double joints per day under all working conditions. The yard was moved approximately every 20 miles, and each move was made in a normal downtime of only 48 hours. The basic design has not been changed from the first Price-designed mobile yard used on the Trans-Canada 34-in. gas transmission line in Western Manitoba in the winter of 1956-57, but automatic features have been expanded, manpower requirements reduced and the whole yard structure streamlined and simplified.

Principal improved features noted in the new model in Alberta were faster welding head

Double-jointing pipe with automatic welding equipment at one of the several pipe yards.

Somastic-coating plant of Pipe Linings Inc. at Milpitas, Calif.

Tying-in pipe section on north slope of Juniper Canyon, Ore. — another instance of difficult terrain.



travelling time, increased comfort for the operator of the travelling boom who has to go inside the pipe for the inside weld, greater control automation, a radically new system on controls for rollers and internal lineup clamp which shortens line-up time, omission of manual tacking before the first pass, and streamlined, more automated handling of pipe from incoming side of the rack through welding head to outgoing side.

An entirely new feature was inclusion of complete automatic electro-hydraulic controls for handling the pipe.

Wide variations in terrain, rock conditions, tree cover, swamps and muskegs over the whole 351-mile main line of the Alberta Trunk Foothills division offered each spread different conditions. The Alberta Natural job encountered almost all possible conditions.

Alberta Natural Section

This was undoubtedly the most difficult Canadian section, traversing a tremendous distance of pure wilderness, mountainous terrain, steep hills, valleys and few access roads along the route. Yard doping was used. To cross Moyie and Flathead, two rugged, steep and almost inaccessible mountains, winding trails had to be brushed out and graded to reach the summit and enormous amounts of rock shot and bulldozed over the edge to grade the right-of-way over the top.

Access and transportation were considered the two biggest problems. There was some access at the south end near the Idaho line, but up and down Moyie Mountain in the southern Kootenay Valley there was only one abandoned logging road to the top. Stringing trucks generally used the right-of-way, and to avoid reloading onto Athey tracks 12 to 14 tow tractors and winches were used.

The superintendent covered the spread every day in a helicopter — the first time this has been done on a Canadian construction job. At times the spread reached 70 miles from end to end, and it would have taken 170 miles of road travelling to visit every gang.

Rainy weather and wet terrain during the early summer compelled using a second spread for 20 miles in order to meet the required completion date. Mannix Co. Ltd. of Calgary constructed this portion.

Several rivers with rock bottoms and exceptionally steep banks were major right-of-way obstacles. The Elk River crossing, for example, had a 60-deg slope on the near side and 45-deg on the down-line side, with a sharp turn up the hill from the top of the bank. A successful experiment carried out on some of the river

crossings was the use of a bulldozer to dig ditch. When water level was low, as much as 200 ft of ditch could be cut in one day.

Two sets of twin drills were used for right-of-way and ditch through rock areas. Little ditch was cut with rotary ditchers. Most ditch hazards were loose glacial boulders of enormous size on hill tops, long stretches of glacial drift with small to medium size boulders where the right-of-way crossed old river beds and flood plains and glacial benches rising steeply in long slopes that required winching even for backhoes. Quite a bit of water from underground springs gathered in low places in mountain areas, and runoff channels were common. Backhoes could cut as much as 800 ft a day each on good gravel beds, averaged 600 ft over-all, but in really rough country with large boulders were slowed down to 200 ft.

Alberta Trunk Section

Alberta Gas Trunk Line was divided into five sections for construction purposes. Section 1 started in the rocky, scenic, timbered, mountain country of Crowsnest Pass. The right-of-way crossed the Livingston Range, east front of the Rocky Mountains, at 6400 ft elevation, about one-third of the way along the route. Rest of the route was through gently to steeply rolling foothills, with some bogs but mostly cultivated farms and grazing land. Glacial drift was prevalent but not troublesome, and there were some good stretches of clay and sandy soil near the north end.

River crossings on the first 50 miles were put in during the winter. Two of the major channels were the Oldman and Crowsnest. For the entire section, six major rivers and several smaller ones were installed. Those laid in winter went in easily through the ice, but tremendous flow in the channel made those laid in the summer more difficult. As an example, on the Sheep River 13 tractors were needed to lower in the crossing although the river channel was barely 200 ft wide.

Pipelaying record for the spread was 13,000 ft a day, but the average was 12,000 ft. The dope gang record was 16,000 ft a day.

Section 2 had great diversity of terrain — level gravel benches near the south end, good sand and clay soils varied with swamps and muskeg, long stretches of steeply rolling sand hills toward the north end, interspersed with muskeg intrusions.

The Bow River, which has a heavy flow of about 15 mph, was laid through ice. The shallow Red Deer, the other principal river on this section, was laid in mid-summer.

Riprap, used extensively to make a solid right-of-way, generally stood up well. Most of the timber for this purpose could be cut on the right-of-way.

Ditching was with trenchers for the most part, and footage was from 12,000 to 14,000 ft a day with three machines. Loose boulders and shale beds in the center part of the section were special ditching problems, but most of the ditch stood up well even through muskeg. Backhoes were used where rotary ditchers could not work.

Reinforced concrete river weights of 4 tons each and extending almost to the bottom of the pipe, were used extensively on this section through muskeg, swamps, river and creek channels.

Section 3, although it contained some of the roughest and toughest deep muskeg in west-central Alberta, was the first to be completed on the entire schedule. All but 7 miles of the pipe was strung and practically all pipe double-jointed during the winter freeze. River crossings were put in through the ice. Equipment was moved across the rivers on ice bridges formed by pumping water through holes in the ice onto the surface, allowing it to freeze, laying down a mat of straw for insulation, and alternating ice and straw layers until enough depth was built up to be safe.

Pipe was laid in single joints on the 22-in. lateral but double-jointed on the 30-in. main line. The pipe gang kicked off the lateral April 27 and welded out in a month for an average of 2 miles a working day. Kickoff on the main line was on May 30, and with an average of 11,000 ft of pipe-laying per day maintained throughout, pipe was welded out on July 1. Doping was completed on July 3.

Ditch was cut with ditchers where feasible, but more often with backhoes working from wooden mats through muskeg and swamps.

Section 4, the wilderness region from Cynthia to Whitecourt, was through muskeg except for the first few miles out of the Pembina field. The line was welded and doped out in the early part of July.

Section 5, the Montana lateral, traversed some of the most scenic country in the southern Alberta foothills. Favored by remarkably good weather from kickoff on June 1, the job was completed on July 15 for average of 1½ miles a day. Terrain, however, was not so favorable. Long, steep grades up and down the foothills were principal obstacles. A special hazard was the presence of many underground springs that often would gush out near hill tops.

A valve setting innovation was introduced on this section. The concrete seats were poured in open ditch before the pipe was welded. This had the double advantage of permitting easier work-

ing and allowing the pipe to be lowered directly onto the blocks instead of being suspended for the pouring.

Compressor Stations

Initially there will be four compressor stations on the Alberta-California system with 16 planned ultimately. The first station is at Crowsnest on the Alberta-British Columbia border. The second is at Samuels, Idaho, between Sandpoint and Bonners Ferry. Wallula station is between Walla Walla and Pasco, Wash., and Yamsay station near Chemult, between Klamath Falls and Bend, Ore.

Spokane, Wash. is field operating headquarters for Pacific Gas Transmission and Antioch, Calif., for Pacific Gas & Electric. Crowsnest station is manned, the others are controlled automatically from Spokane. Spokane, however, relays instructions over the communications system to Crowsnest. There are no stations in California at present.

Crowsnest station, with a total of 13,600 hp is the largest. Four 3400-hp gas engine driven angle reciprocating type compressors have been installed. This is the only station pumping gas during the initial phase of operation. The other three are under construction, however, and soon will be on the line.

Sandpoint will have one 6000-hp gas turbine driving a centrifugal compressor.

Wallula will have two 5000-hp gas engines driving centrifugal compressors.

Yamsay also will have two 5000-hp gas engines driving centrifugal compressors.

Each engine will have a control panel that will shut it down should anything serious go wrong even though the units are being remotely controlled from Spokane.

Control Center

The control center at Spokane provides for remote supervisory control of compressor stations and major meter stations. Design of the system provides for additional compressor stations in the future.

The basic control concept is one of local automatic control at each compressor station to comply with set-point established by supervisory control. Supervisory equipment scans continuously all remote points, and only about 1 min is required for updating data, alarms, status indicators and other information from any station. Information is presented by means of electric typewriters, digital visual display boards and status-alarm lights arranged for maximum operator convenience.

Local station automation is controlled remotely for some stations and operator assistance is provided in others. Exact mode of operation depends upon the type of compressor involved. In the case of reciprocating units, discharge pressure is maintained by engine speed control and selection of the number of units on line. The desired set-point is telemetered to unattended stations and set in manually at others. Attended stations have provisions for future unattended operation. When more than one compressor unit is in operation, small and different offsets are injected in each governor to prevent resonant-speed effect.

A secondary control maintains load at or near rated torque over expected ranges of flow and pressure by changing pocket clearances. Pocket clearance changes are provided only at periodic intervals so there will be no interaction with the primary control loop.

Proper clearance for rated torque is derived from a plotter-controller built around a conventional X-Y plotter. In place of the normal writing stylus in the plotter, a contact stylus is lowered onto the etched boards that contain the families of torque curves for the compressors.

A different type of control varies engine speed of the turbine-driven compressors. Also, there is an engine panel with outputs to control pre-lubrication, starting air, ignition, fuel gas, pump valve and pocket setting.

The control system is designed to accommodate as many as 98 remote stations, each having up to 14 data points, 14 control points and 44

Five pipelayers lower Somastic-coated pipe into trench near Maxwell, Calif.

status and alarm points, or any equivalent combination of this total.

The telemetry portion of the system employs a design to insure fail-safe operation even should there be communication, component or power failure. Data conversion — analog-to-digital or vice versa — is accurate to one part in a thousand and message transmission accuracy is absolute.

Possible maintenance and service difficulties are minimized by plug-in logic boards. All system functions are accomplished by a series of standard etched phenolic boards. Standard maintenance includes use of a built-in marginal test circuit. Here two primary operating voltages are lowered so that any marginal operation becomes apparent immediately. As a further service aid, a standard universal test instrument is being provided that will make it possible for non-technical personnel to maintain the equipment.

Of particular interest to the pipeline industry are the considerations given in the design to anticipate control developments including computer control. High-speed data transmission and interrogation, high data density, computer code language and other techniques made possible by solid-state circuits are being used for compatibility with modern general-purpose digital computers.

New to this particular control system are the pocket clearance computer, centrifugal compressor control, the manner in which total control is being effected and the extent to which SIE Div. of Dresser Electronics, designer and builder, has gone to make maintenance and service easy for the non-technical man. Otherwise the system is probably no more advanced at this time than some others now in operation. However, future additions may change this picture rapidly due to PG&E's thinking on total line control and the work being done with Dresser/SIE and the research group employed by the latter, Texas Research Associates.

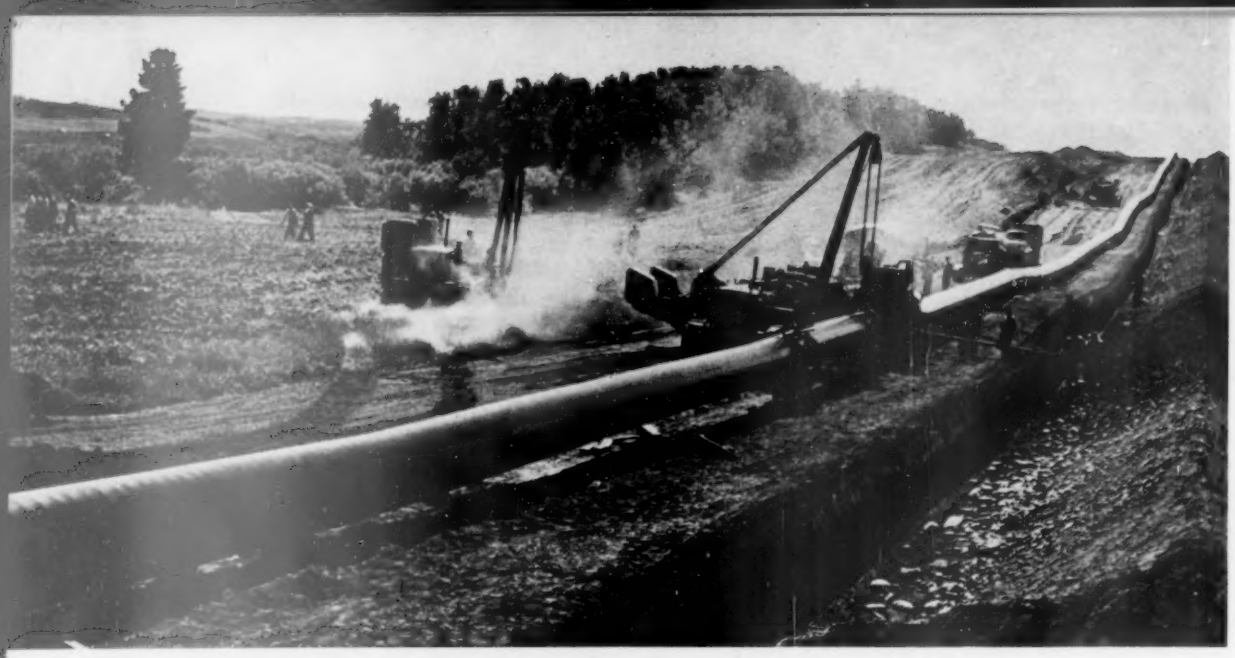
Communications System

A company-designed, owned and operated microwave communications system has been installed on the U. S. portion of the pipeline. In Canada, microwave and wire circuits are being leased from the British Columbia Telephone Co. and Canadian Pacific Railway.

These are the types of circuits on the U. S. microwave system: (1) dispatcher, (2) remote control of individual compressor on a fail-safe basis, (3) supervisory and control, (4) telemetering, (5) maintenance, (6) VHF mobile radio, (7) administrative communications, (8) teletype and (9) facsimile.

The microwave system is composed of 24 backbone microwave sites, 10 spurs and 16 VHF base stations to provide these services. A mobile relay option in the VHF system extends the range of mobile radios in their respective operating areas. The mobile system, in conjunction with the pipeline microwave network, provides communications between each

Pipe was double-jointed, cleaned, internally and externally coated at this Winona, Wash., plant.



Coating and wrapping pipe trenchside on the Livingston Range near Blairmore, Alta.

mobile unit and control centers at Spokane and Antioch. Ninety-six vehicles are equipped with mobile radios for management and maintenance personnel. In addition, there are 11 portable radiophones.

Motorola microwave RF equipment operates in the 6-kmc region and provides 1 w into the antennae system. Motorola also furnished radio buildings, towers, antennas, VHF mobile radio and base stations on an EF&I basis for the PGT portion of the system. Lynch Communication Systems Inc. supplied the solid state radio multiplexing equipment, type B910, including VHF control channels, tone equipment, subscriber carrier telephone system. SIE Div. of Dresser Electronics, as has been mentioned, supplied telemetry and full supervisory remote control equipment. Noller Associates furnished microwave alarms. Graybar Electric Co. in addition to providing accessory items such as W. E. 1A1 key sets, teletype machines, EMX-2 long line adapters, party line dispatching trunks, E&M ringdown converters, contracted installation of the Lynch multiplexing and tone equipment in the PGT portion of the system.

The multiplexing equipment provides up to 96 channels in the 60 to 552-kc spectrum without master oscillators or supergroup equipment. This system is capable of being expanded in the 560 to 2540-kc spectrum to provide a total of 576 possible communication channels.

The multiplex system was designed to allow voice circuits above 58 kc and data circuits below to provide maximum utilization of the available spectrum. Teletype and telemetry information is transmitted via the tone multiplex equipment. Tone equipment is applied directly to radio baseband frequencies with approximately 50 channel capability below 58 kc. Direct modulation of the tone channels to baseband frequencies eliminates additional voice channels normally used to introduce data information to the microwave system.

Underground Storage

As an important adjunct to the pipeline system, Pacific Gas & Electric Co. will place in operation this month (November) one of the largest capacity underground storage fields in the U. S. for peak shaving. McDonald Island gas field northwest of Stockton, under development for some time as a storage reservoir, will have a working storage capacity of 30 billion cu ft and ultimately be able to deliver 400,000,000 cu ft a day. Initially, it will deliver about 75,000,000 cu ft a day.

PG&E acquired the field from Standard of California in 1958 and began injecting gas into several of the existing wells, at the same time initiating a program of repairing the wells. Now nearing completion is a building to house a 2000-hp motor driven compressor, that will inject gas into the reservoir, gas dehydrators, scrubbers, and a 60,000-v electric substation. The building is on a concrete platform 17 ft above ground as a safeguard should the levees that border the island fail. Supports are 137 piling sunk 60 ft into the sandy soil. Another compressor 17 miles west at Brentwood Terminal station boosts gas through an 18-in. line to McDonald Island.

Trencher easily marches along west of Calgary in eastern foothills of Rocky Mountains where there was no interference from rock.

Automatic joiner applies Somastic coating over joint welded in the field . . . taking 4 min compared with 40 min by older manual method.

Contractors

Contracting firms participating in the gigantic Alberta-California pipeline, which will cost in excess of $308,000,000 are:

Bechtel Corp. and Canadian Bechtel Ltd.: engineering-management services.

H. C. Price Co.: 296 miles of main line from Antioch, Calif., to the Oregon line; 146 miles of mainline from Rosalia, Wash., to the Idaho-British Columbia border; Somastic coating of pipe for the California section and for some of the river crossings.

Western Pipe Line Inc. and J. P. Neill and Co. (joint venture): 468 miles of main line from California-Oregon border to Rosalia, Wash.

Majestic Contractors Inc.: 113 miles of main line from Alberta-British Columbia border to Priddis, Alta.; 63 miles of main line from Rocky Mountain House, Alta., to west of Cynthia; and 38 miles of 22-in. lateral from Rocky Mountain House to Homeglen-Rimbey gas field.

Alberta Consolidated Pipe Line Builders (joint venture of Mannix Co. Ltd., Piggott Construction Ltd., Banister Construction Co. Ltd., and Marine Pipeline & Dredging Ltd.): 113 miles of main line from Priddis to near Rocky Mountain House, Alta. and 64 miles of 16-in. delivery lateral from Blairmore to Carway, Alta., near the Montana border.

Piggott Construction, Ltd.: 43 miles of 20-in. northeast of Kaybob, Alta.

Dutton-Williams Bros. Ltd.: 62 miles of main line from West Cynthia to west of Whitecourt, Alta.; then 20 miles of 22-in. lateral to Whitecourt field.

Price-Poole of Canada Ltd. (joint venture of H. C. Price of Canada and Poole Construction Co.); 107 miles of main line from Crowsnest Pass, B. C., to Idaho border at Kingsgate-Eastport.

Hood Corp.: crossing of San Joaquin and Sacramento rivers and Sherman Island.

Henuset Bros. Ltd.: lateral lines in Canada.

Kaiser Corp.: Wallula and Yamsay stations.

Eichleay Corp.: Sandpoint (Samuels) station.

Thomas Contracting Co.: line testing in Idaho, Washington and Oregon.

Mannix Co. Ltd.: line testing in British Columbia.

River Construction Co.: Kootenai and Pend Oreille river crossings.

Missouri Valley Dredging Co.: Snake River crossing.

Stanley-Bledsoe Corp.: double-jointing, yard-wrapping, internal-coating on Western-Neill spreads.

L. C. Russell Co.: internal coating.

R. F. Walsh Co.: internal coating.

Dunn Bros.: stringing.

Canadian-Parkhill Pipe Stringing Ltd.: stringing.

Bigge Drayage Co.: stringing.

Motorola Communications & Electronics: microwave system.

Lynch Communications Systems, Inc.: multiplexing system.

SIE Div. of Dresser Electronics: controls system.

■

by Frank H. Love

Oil Lines Gain, Overall Construction Drops

Pipeline construction has declined rather sharply this year compared with 1960 but is still more than 2000 miles ahead of 1959. Healthy mileage laid in Canada and a rise in crude oil line construction have given 1961 figures their biggest boost.

World-wide, 24,541 miles of pipelines have been completed or are under construction for the 12 months ending Oct. 1. There were 31,376 miles at the corresponding date a year ago.

In gas line construction, declines were witnessed in the United States and internationally. Canada exceeded expectations.

Products pipeline construction in the U. S. held steady internationally and showed a gain in Canada.

Crude oil lines gained in the U. S., internationally and in Canada.

The outlook calls for 31,076 miles of new pipelines projected compared with 34,730 miles a year ago, according to PIPELINE ENGINEER's annual construction report based on data provided by operating companies and by government agencies in countries where the petroleum industry is nationalized.

U. S. companies expect an increase in construction. There will be some decline internationally. But the heaviest loss will be in Canada, which has just had an especially good year.

This year we are presenting our statistical tables in a different form, and information on costs, and horsepower installed and proposed is an added feature.

We think it important to point out again that under "pipelines planned or proposed" there are always projects that will not be consummated during the next 12 months, nor even started. Consequently, there are never as many miles of pipeline laid as there are projected. Some plans take several years to come to fruition; others eventually may be abandoned. So long as they are under consideration, however, we feel they should be included in the report.

Pipelines built or under construction (as of Oct. 1, in miles)

	1960	1961
U. S.	15,353	11,125
Canada	908	2,333
International	15,115	11,083
Total	31,376	24,541
GAS	1960	1961
U. S.	11,273	7,113
Canada	490	1,200
International	6,132	1,842
Total	17,895	10,155
PRODUCTS	1960	1961
U. S.	3,354	2,575
Canada	none	252
International	2,319	2,349
Total	5,673	5,176
CRUDE	1960	1961
U. S.	726	1,437
Canada	418	881
International	6,664	6,892
Total	7,808	9,210

Pipelines planned or proposed:

	1960	1961
U. S.	11,297	12,725
Canada	8,167	3,941
International	15,266	14,410
Total	34,730	31,076
GAS	1960	1961
U. S.	6,371	8,515
Canada	2,242	805
International	9,527	8,568
Total	18,140	17,888
PRODUCTS	1960	1961
U. S.	2,940	3,773
Canada	2,734	none
International	1,110	3,335
Total	6,784	7,108
CRUDE	1960	1961
U. S.	1,986	437
Canada	3,191	3,136
International	4,629	2,507
Total	9,806	6,080

Statistical tables on "Pipelines Built and Underway" and "Pipelines Proposed or Planned" follow ➠

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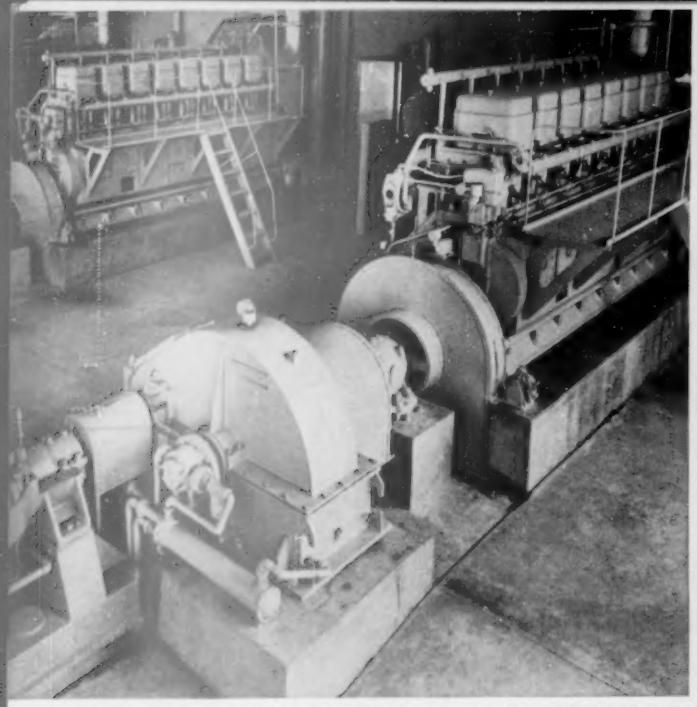
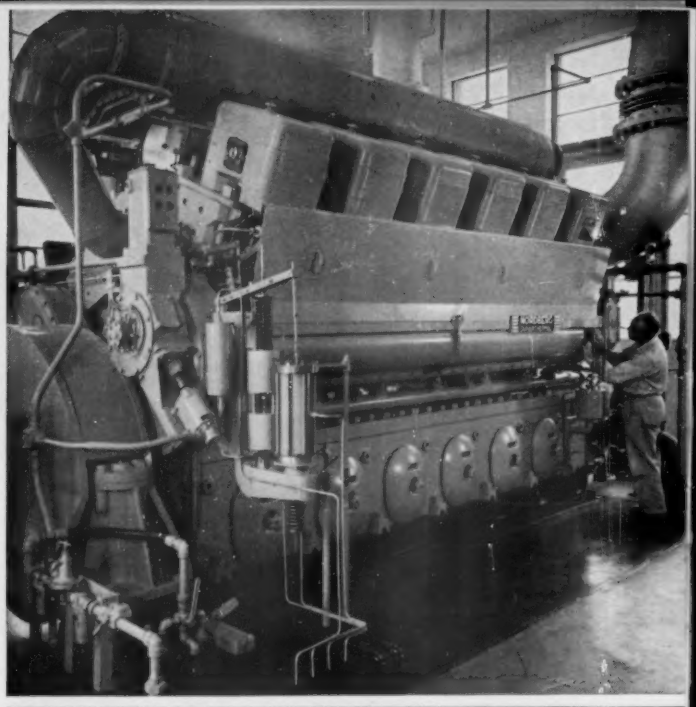
PIPELINES BUILT OR UNDERWAY

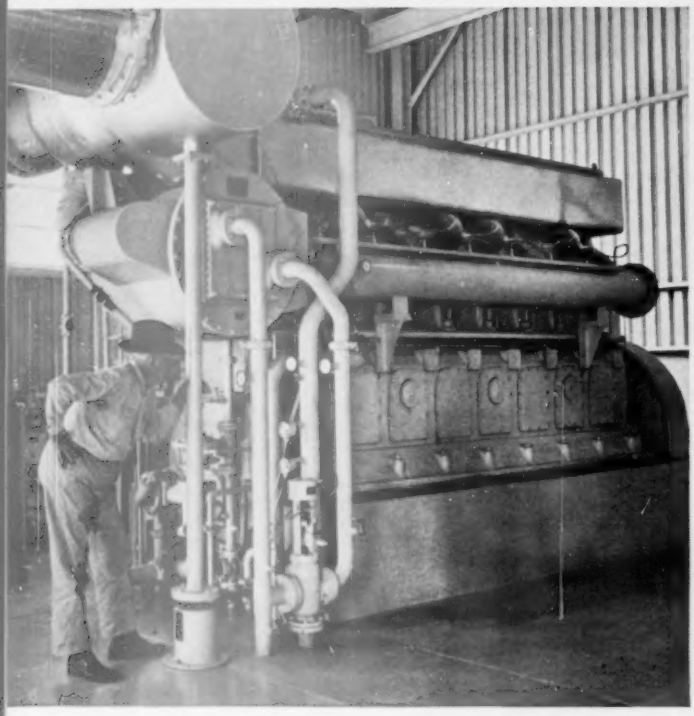
COMPANY	Crude	Products	Gas	Miles	Diam. In.	Location	Completion	Cost
Act Oils, Ltd. Montreal, Canada	—	—	—	—		—	—	—
Alamo Gas Supply Co. San Antonio, Texas	—	—	—	—	—	—	—	—
Alberta Gas Trunk Line Co. Ltd. Calgary, Alta., Canada	—	—	√	349	30, 36	Coleman to Rocky Mountain House to Windfall, Alta.	11/61	
	—	—	√	63	16	Bermis to Carway, Alta.	11/61	
	—	—	√	24	22	Cochrane to East Calgary	11/61	
	—	—	√	38	22	Rocky Mountain House to Rimbey	11/61	
	—	—	√	43	16, 22	Cochran, Crossfield, Windfall, Alta.	11/61	$89,000,000
Alberta Natural Gas Co. Calgary, Alta., Canada	—	—	√	107	36	British Columbia Alberta Border to British Columbia Idaho Border.	1961	$34,024,000 (Canadian $)
American Independent Oil Co. San Francisco, California	√	—	—	32	24	Wafra field, Neutral Zone, to Mina Abdullah, Kuwait.	10/61	—
American Louisiana Pipe Line Co. Detroit, Mich.	—	—	√	24	24	Krotz Springs to Lawtell, La.	5/61	$2,000,000
American Oil Co. Chicago, Ill.	—	—	—	—	—	—	—	—
American Petrofina Co. Dallas, Texas	—	—	—	—	—	—	—	—
Anadarko Production Company,	—	—	√	7.6	4, 6, 8	Gathering Facilities in Kansas, Oklahoma, Texas	1/61	
Panhandle Eastern Subsidiary Kansas City, Mo.	—	—	√	82	10-12	Spivey, Kansas to El Dorado, Kansas	8/61	—
Arabian American Oil Co. Dhahran, Saudi Arabia	√	—	—	29	30-32	Loops between Safaniya and Khursaniyah, Saudi Arabia	10/61	
	√	—	—	30	24	Offshore Safaniya	UC	
	—	√	—	37	8	Abqaik to Ain Dar, Saudia Arabia	1961	—
Arapahoe Pipe Line Co. Palatine, Illinois	√	—	—	25.3	2-6	Miscellaneous lines	UC	$235,000
Arkansas Western Gas Co. Fayetteville, Ark.	—	—	√	10	12	Brashears to Cannon Creek, Ark.	UC	$375,000
Ashland Oil & Refining Co. Ashland, Ky.	—	√	—	24	6	Blaine, Ky., to Catlettsburg, Ky.	1961	—
Atlantic Seaboard Corp. Charleston, W. Va.	—	—	√	6.4	20	Between Granite and Owings Mill, Md.	8/61	—
Attock Oil Co., Ltd. Morgah, Rawalpindi, West Pakistan	√	—	—	55	6	Dhulian field to Morgah	—	—
Basrah Petroleum Co., Ltd. London, England	—	—	√	65	12-16	Zubair to Fao, Iraq	1961	
	√	—	—	20	16	Gathering lines, Rumaila field, Iraq	1961	
	√	—	—	37	—	Rumaila field to Basrah	UC	—
Belle Fourche Pipe Line Co. Casper, Wyo.	√	—	—	12	6	Raven Creek field to Donkey Creek, Wyo.	2/61	
	√	—	—	31	8	Donkey Creek to Fiddler Creek, Wyo.	2/61	
	√	—	—	13	8	Fiddler Creek to Osage, Wyo.	8/61	$1,900,000
Bi-Stone Fuel Co. Corsicana, Tex.	—	—	—	—	—	—	—	—
Bituminous Oil Pipeline Co. Calgary, Alta., Canada	—	—	—	—	—	—	—	—
Border Gas Transmission Corp. San Antonio, Tex.	—	—	—	—	—	—	—	—
Britamoil Pipe Line Co. Calgary, Alta., Canada	—	—	—	—	—	—	—	—
British Col. Oil Transmission Co., Ltd. (Sun, Fargo Oils, Western Natural Gas, General American)	√	—	—	85	—	Gathering System and lateral to serve Blueberry field of northeastern B. C.	UC	$8,000,000
The Buckeye Pipe Line Co. Lima, Ohio	—	√	—	42	8	Flint to Bay City, Mich.	UC	
	—	√	—	28	8	Lima, Ohio, west	UC	—

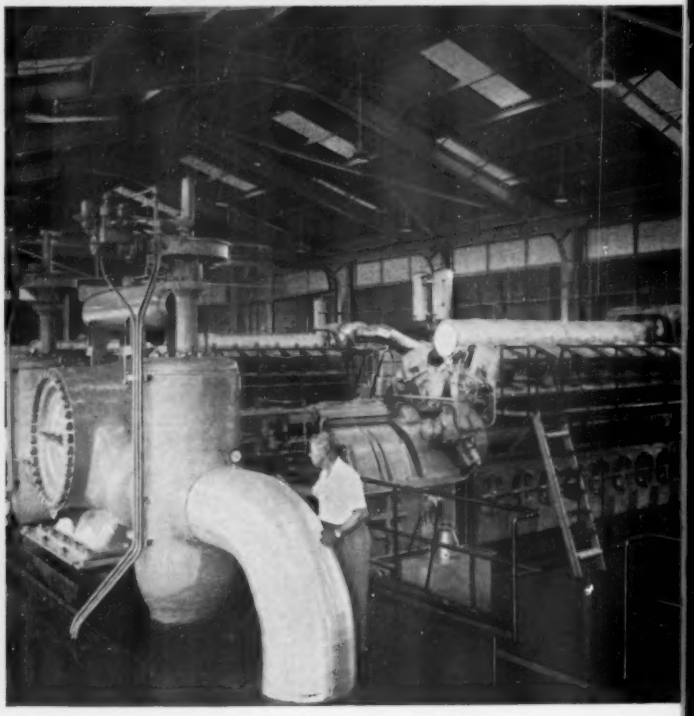
PIPELINES PROPOSED OR PLANNED

Crude	Products	Gas	Miles	Diam. In.	Location	Cost	HP added last 12 months	HP Planned	Cost
√	—	—	425	—	Fort St. John area to Bella Coola, B. C.	—	—	—	—
—	—	√	96	20 24	Southwest Texas to San Antonio	—	—	—	—
— —	— —	√ √	29 25	8 6, 12	Kessler to Consort, Alta. Buck Lake and Wayne, Alta.	$1,500,000	—	3,500	$2,000,000
—	—	—	—	—	—	—	13,600	—	—
—	—	—	—	—	—	—	—	—	—
—	—	√	25	8	Holly Ridge Field, La. to Main Line	$750,000	—	—	—
—	√	—	—	—	—	—	—	400	$80,000
—	√	—	133	6	Mt. Pleasant to Grapevine, Texas	$2,500,000	—	—	—
—	—	—	—	—	—	—	—	—	—
√	—	—	27	24	Northern Safaniya to Southern Safaniya	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	√	1	10	Fayetteville, Ark. to Hebbard Setting	$30,000	700	—	$100,000
—	—	—	—	—	—	—	—	—	—
—	—	√	40 3	30	Loudon County, Va., to Howard County, Md.	$5,111,000	—	4,400	$2,977,000
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	450	—	$54,000
—	—	√	175	10, 16	Bethel, West Anderson County, Tex., to Merit, Hunt County, to Savoy, Fannin County, and to McKinney and Denton areas	—	—	—	—
√	—	—	250	—	Athabasca oil sands in northeastern Alberta to Edmonton	—	—	—	—
—	—	√	350	—	Gathering lines in Webb, Zapata, Starr, Jim Hogg, Brooks, Dimmit, Zavala, Maverick and LaSalle counties, Texas	—	—	—	—
√	—	—	65	12	Rimbey field to Edmonton	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	√	—	—	—	—		1,425	 3,350	$237,000 $472,000









Pipe line engines by Nordberg

Nordberg engines are a sound investment in long term pipe line power.
Consult Nordberg on your crude, products or gas pipe line programs.

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NORDBERG MANUFACTURING COMPANY
MILWAUKEE 1, WISCONSIN

ATLANTA • CLEVELAND • DALLAS • DULUTH • HOUSTON • KANSAS CITY • MINNEAPOLIS
NEW ORLEANS • NEW YORK • ST. LOUIS • SAN FRANCISCO • TAMPA
WASHINGTON • TORONTO • VANCOUVER • JOHANNESBURG • LONDON • MEXICO, D. F.

Trunkline waltzes through Vienna

The firing line welds multiple pipe joints for one of many road crossings.

That's Vienna, Illinois, a key point on Trunkline Gas Company's main line bringing natural gas from Texas and Louisiana to midwestern customers.

The snaking operation you see here took place in late spring of 1961, as Trunkline sped ahead with the construction of 154 miles of 30-in. x .361-in. main-line loops. Pipe for this 21-mile spread, extended north from Vienna, was supplied by Bethlehem Steel, and laid by Western Pipe Lines, Inc. We also furnished the pipe for Trunkline's 20-mile loop north of Oak Grove, Louisiana, where Panama-Williams, Inc., was contractor.

These days you can find Bethlehem High-Test Line Pipe on more spreads than ever before. That's because we recently expanded our output to meet the increasing demand for top-quality line pipe in diameters clear up to 42 in.!

Bethlehem Steel offers a full line of line pipe: From Sparrows Point, Md.—continuous buttweld from ½ through 4 in., nom., and electric resistance-weld from 5$\frac{9}{16}$ through 16 in., OD. From Steelton, Pa.—electric fusion-weld from 18 through 42 in. OD. All Bethlehem line pipe meets appropriate API standards.

Steel

for Strength
... Economy
... Versatility

BETHLEHEM STEEL COMPANY, Bethlehem, Pa. *Export Sales:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

HOW WESTERN GEAR SERVES THE PETROLEUM AND NATURAL GAS INDUSTRIES

HERE'S WHY WESTERN GEAR PIPELINE DRIVES ARE IN WORLD-WIDE SERVICE

Outstanding records of *reliable* performance under all types of operating conditions with a minimum of maintenance attention have established Western Gear pipeline drives as the standard of comparison in the industry. Reliability doesn't just happen . . . it requires top engineering and manufacturing techniques teamed with broad experience in all types of pipeline drive requirements.

Check these important features found in every W G pipeline drive:

1. Precision manufacture: assures quiet operation, peak efficiency, up to 99%.

2. Tough double helical gearing: precision hobbed and shaved from high alloy steel forgings, heat treated for years of dependable service.

3. Sleeve-type journal bearings: babbitted tin base alloy, bronze backed. Larger units have removable caps for easy accessibility.

4. Rugged housings: cast or fabricated, depending on unit size. Generous internal rib and gusset reinforcing for clean appearance and strength.

5. Flexible lubrications systems: standard integral type or special systems to meet any installation requirement.

6. Rigid quality control: close tolerances, mill-to-finished product material inspection including magnetic and ultra-sonic surveys where necessary.

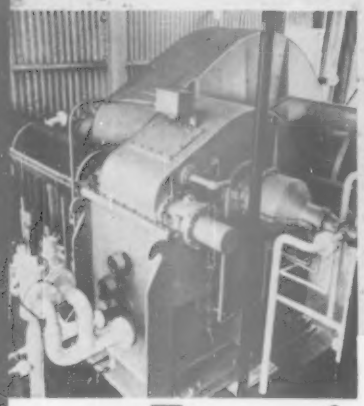
7. Unsurpassed experience: scores of single or multiple stage drives in world-wide service—Transwestern, Columbia-Gulf, Texas Eastern, Transmountain, Warren Petroleum, Union Oil, Trans-Arabian, Petroleos Mexicanos, Spanish Pipeline, Richfield Oil, Great Lakes, Mid-Valley and others.

For complete information on Western Gear pipeline drives, write, wire or phone:

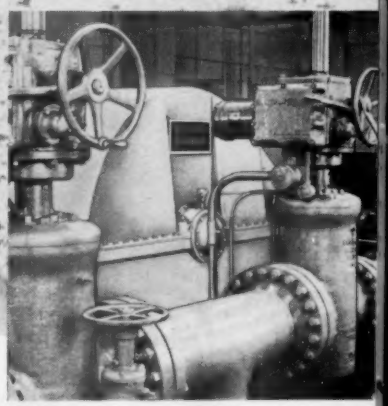
WESTERN GEAR CORPORATION
Industrial Products Division
P.O. Box 126, Belmont, Calif.
LYtel 3-7611

WG PIPELINE DRIVES ARE BACKED BY 70 YEARS OF SERVICE TO INDUSTRY

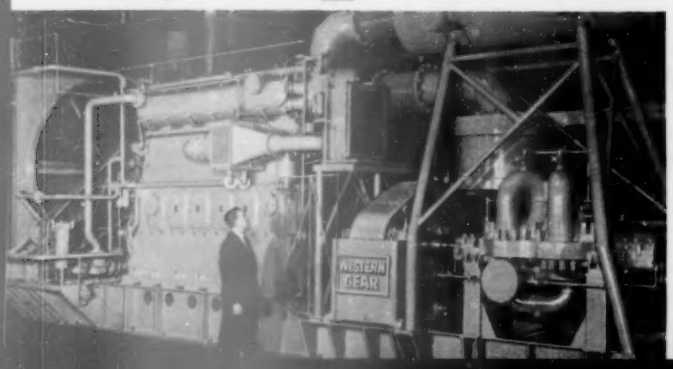
On the long run . . . **QUALITY COSTS YOU LESS!**

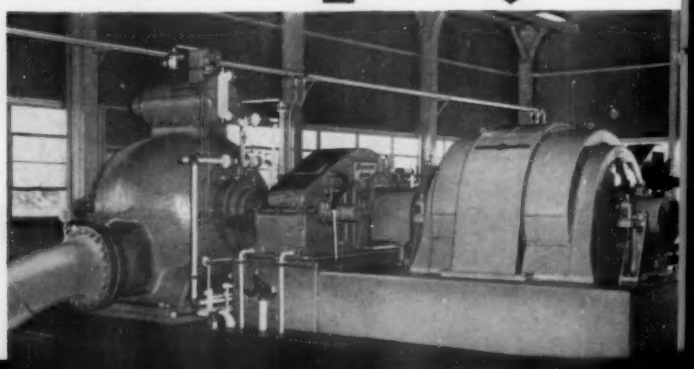


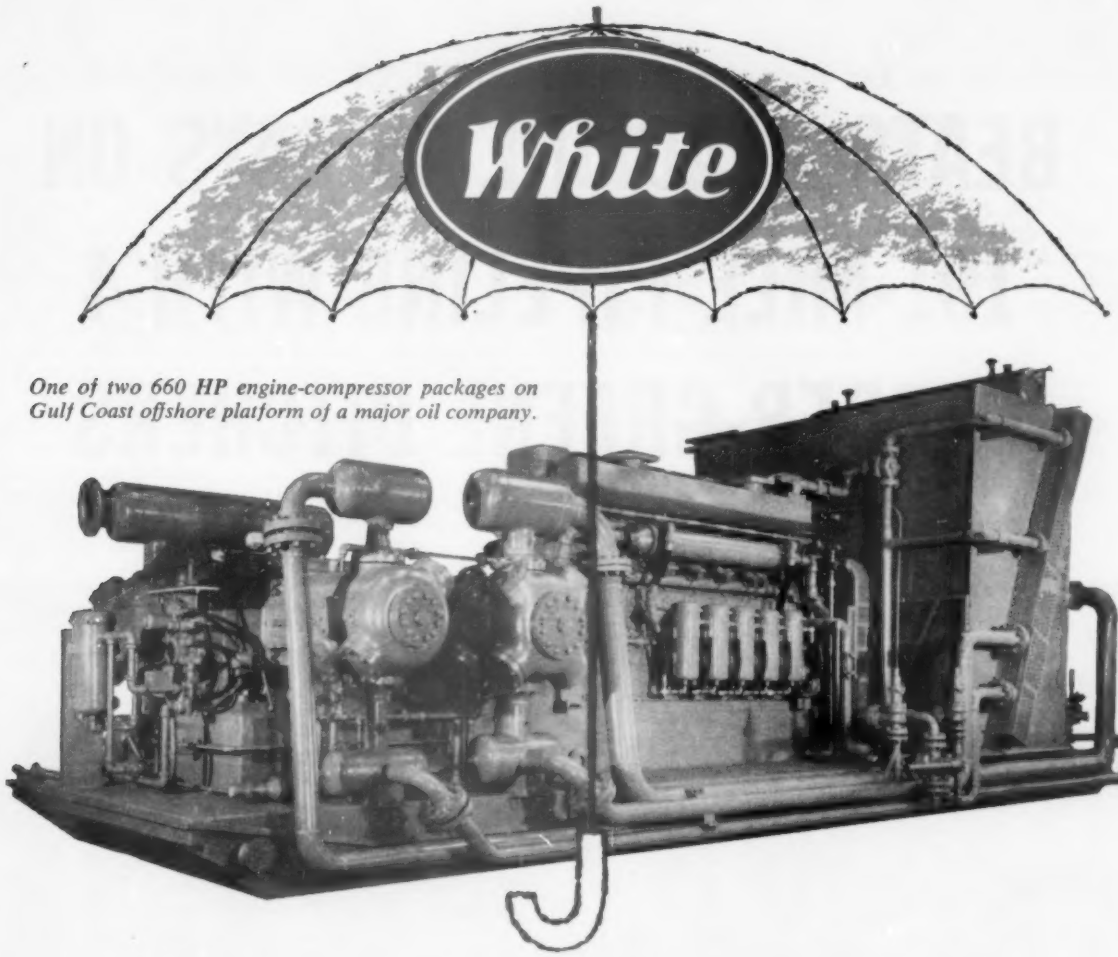
1. *Western Gear hi-speed unit boosts 600 RPM 925 HP at engine input to a 3550 RPM centrifugal pump at a pumping station of American Independent Oil Co. in Kuwait.*
2. *One of 2 Western Gear Model 300HS150 units installed for El Paso Natural Gas Company in its Leupp, Arizona station . . . 5750 HP from 1200 RPM electric motor to 8500 RPM centrifugal compressor.*
3. *One of 20 two-stage hi-speed drives which step up 5000 HP 327 RPM engines to centrifugal compressors at 6055 RPM for Columbia-Gulf.*
4. *Western Gear speed increasers like this are used exclusively on Mid-Valley's 1,000-mile pipeline. A total of nine 1200 HP 450/3600 RPM and seventeen 1700 HP 327/3600 RPM units are in service.*



WESTERN GEAR DRIVES HAVE BEEN SELECTED FOR THE NEW CALIFORNIA-ALBERTA GAS PIPELINE FEATURED IN THIS ISSUE OF *Petroleum Engineer*







One of two 660 HP engine-compressor packages on Gulf Coast offshore platform of a major oil company.

White's single responsibility covers Engine and Compressor ALL THE WAY

White-Superior 200/1000 BHP Compressors are designed for exact match with Superior *medium speed* gas engines. Both units are precision built to identical standards at White in Springfield. White therefore assumes *complete and undivided responsibility* for all vital parts on its direct-driven, balanced opposed engine-compressor sets.

Single responsibility *all the way* starts with pre-engineering (selecting the right combination for your job) . . . extends through manufacturing, the installation alignment check-out and start-up.

White also provides on-the-job training of your personnel for proper operation and maintenance of complete unit. You'll find factory service and parts readily available from White's extensive field service organization.

Two, four and six-cylinder, single or multi-service compressors are available properly packaged (see list) and ready for service. For engineering assistance or Bulletin 124, contact nearest White representative or write today to White Diesel Engine Division, Springfield, Ohio.

White DIESEL | Superior ENGINES

White Diesel
ENGINES / COMPRESSORS

WHITE'S AUTHORIZED PACKAGERS

West Coast	Guy T. Martin & Co., Inc.
Rockies	Stearns-Roger Mfg. Co.
Mid-Continent	Southwest Industries, Inc.
Canada	Southwest Barber, Ltd.
Canada	Stearns-Roger Engr. Co., Ltd.

BEATS DEADLINE 45 DAYS ON 191-MILE PIPELINE WITH 4 BARBER-GREENE DITCHERS

H. C. Price Co. takes 11,000-ft. mountain slopes, snow, solid rock and dust in stride to complete $3,000,000 gas distribution system.

The H. C. Price Co., Bartlesville, Okla., beat a contract completion date by 45 days on a $3,000,000 Colorado gas distribution system with an assist from a fleet of four Barber-Greene Ditchers.

Supt. Spike Adams used a Barber-Greene 774 on his 95 mile main line section of the 191 mile project. The 774 dug all the trench a ditcher was able to handle on the route which crossed 11,000-ft. Grand Mesa Mountain. The machine worked up to 12 hours daily, seven days a week on steep slopes, in rock and boulders and through snow atop the big flattop.

Supt. Darold Worley of the distribution spread used three Model 772's to dig 80% of 96 miles of trench for the distribution lines and says:

"We were very pleased with the trench-opening speed of our Barber-Greene 772's. Ability to control digging wheel and track speeds independently helped us handle toughest digging faster. The independent hydraulic conveyor drive let us work tight quarters easily while keeping spoil the proper distance from the trench. Repairs were no problem. One 772 dug 25 miles and all we replaced was a rock guard and a hydraulic pump part."

See your Barber-Greene Distributor for details on the only modern pipeline and utility ditcher line. Exclusive dual-range Hydra-Crowd transmissions let Barber-Greenes trench faster in all working conditions and simplified design make them the easiest ditchers to maintain.

ONE OF PRICE'S THREE Model 772 Barber-Greene Ditchers, opposite page, is shown opening distribution line trench. These machines, all with 5½-ft. wheels, dug 80% of 96 mile phase of contract.

ONLY DITCHER in main line spread was this rugged Model 774 that dug 32 miles of 40 x 26" trench across snow-capped mountain, on rock-ribbed slopes and in extremely dusty conditions.

PERFECT CONTROL of spoil is shown here as Model 772 works close to poles in alleyway of one of six communities served by Rocky Mountain Natural Gas Company's new system.

Crawler or rubber-tired Barber-Greene Vertical Boom Ditchers cut low cost trench from 5½ to 24-in. wide and to 7-ft deep. Model 784 is shown.

Manufacturer of the only modern ditcher line

Representatives in Principal Cities of the World

Barber-Greene BG

Main Office and Plant AURORA, ILLINOIS, U. S. A.
Other Plants: DeKalb, Milwaukee, Detroit, Canada, England, Brazil, Australia

CONVEYORS • LOADERS • DITCHERS • ASPHALT PAVING EQUIPMENT

PIPELINES BUILT OR UNDERWAY

COMPANY	Crude	Products	Gas	Miles	Diam. In.	Location	Completion	Cost
Butte Pipe Line Co. Houston, Tex.	√	—	—	—	—	—	—	—
California Gas Transmission Co. Los Angeles, Calif.	—	—	—	—	—	—	—	—
Calnev Pipe Line Co. Colton, Calif.	—	√	—	230	8	Las Vegas, Nev., to Colton, Calif.	3/61	—
Canadian Industrial Gas, Ltd. Calgary, Alta., Canada	—	—	—	—	—	—	—	—
Carolina Pipeline Co. Columbia, S. C.	—	—	√	87	8, 10	Aiken to Camden, S. C.	10/61	—
Cartier Gas Corp. Toronto, Canada	—	—	—	—	—	—	—	—
Central Illinois Public Service Co. Springfield, Ill.	—	—	√	15.5	10	Near Tuscola, to Mattoon, Illinois	1960	
	—	—	√	22.2	4	Near Macon, Moweaqua, Blue Mound and Assumption, Ill.	UC	
	—	—	√	4	8	Replacement to bypass Kansas, Ill.	UC	$578,680
Champlin Oil & Refining Co. Enid, Okla.	√	—	—	87.9	4, 6	Dover-Hennessey fields to Enid refinery	7/61	
	—	√	—	2.3	6	Nebraska side of Missouri River, near Sioux City, Iowa, to South Dakota side	6/61	$1,571,000
Cities Service Pipe Line Co. Bartlesville, Okla.	—	—	√	15.0	8-16	Near Neosho and Springfield, Mo.	5-7/61	
	—	—	√	35.2	4-12	Near Vinita, Okla., and in Pawnee, Nowata, Osage, and Grant counties, Okla.	1961	
	—	—	√	36.4	4-30	Barber, Marion, Grant, Finney counties, Kan.	1961	
	—	—	√	6	8	Buchanan and Doniphan counties, Mo.	12/60	
	—	—	√	5	16	Joplin, Mo.	5/61	
	—	—	√	35.7	10, 12, 20, 26	Replacement in Joplin, Mo.; Loop line in Gray County, Kan.; from Grady County to Comanche Co., Okla.; Franklin County, Kan.	UC	—
Citizens Gas & Coke Utility Indianapolis, Ind.	—	—	√	71	12-20	Worthington to Indianapolis, Ind.	UC	—
Coastal Transmission Corp. Houston, Tex.	—	—	—	—	—	—	—	—
Colorado Gas Transmission Co. Colorado Springs, Colo.	—	—	—	—	—	—	—	—
Colorado Interstate Gas Co. Colorado Springs, Colo.	—	—	—	—	—	—	—	—
Colorado Oil & Gas Co. Denver, Colo.	—	—	—	—	—	—	—	—
Colorado-Wyoming Gas Co. Denver, Colo.	—	—	√	4	3, 4	Main lines to Niwot and Valmont, Colo.	6-7/61	
	—	—	√	17	16	Henderson to Louisville, Colo.	10/61	
	—	—	√	4	4	Main line to Erie, Colo.	10/61	$1,006,000
Columbia Gulf Transmission Co. Houston, Tex.	—	—	√	12	6, 8, 10	Terrebonne Parish, St. Mary Parish, Jefferson Davis Parish, Louisiana	12/60	—
Compagnie d'Exploration Petroliere Paris, France	—	—	—	—	—	—	—	—
The Consumers Gas Co. Toronto, Ont., Canada	—	—	√	24	8	Alexandria to Hawkesbury, Ont., Canada	UC	
	—	—	√	56.5	8	Arnprior to Renfrew, Ont., Canada	UC	—
Continental Pipe Line Co. Ponca City, Okla.	√	—	—	28	6, 8	Grand Isle to Golden Meadow, La.	4/61	
	√	—	—	54	3, 4	Kingfisher gathering system	7/61	$17,502,599 (combined with Glacier Pipe Line Co.)

PIPELINES PROPOSED OR PLANNED

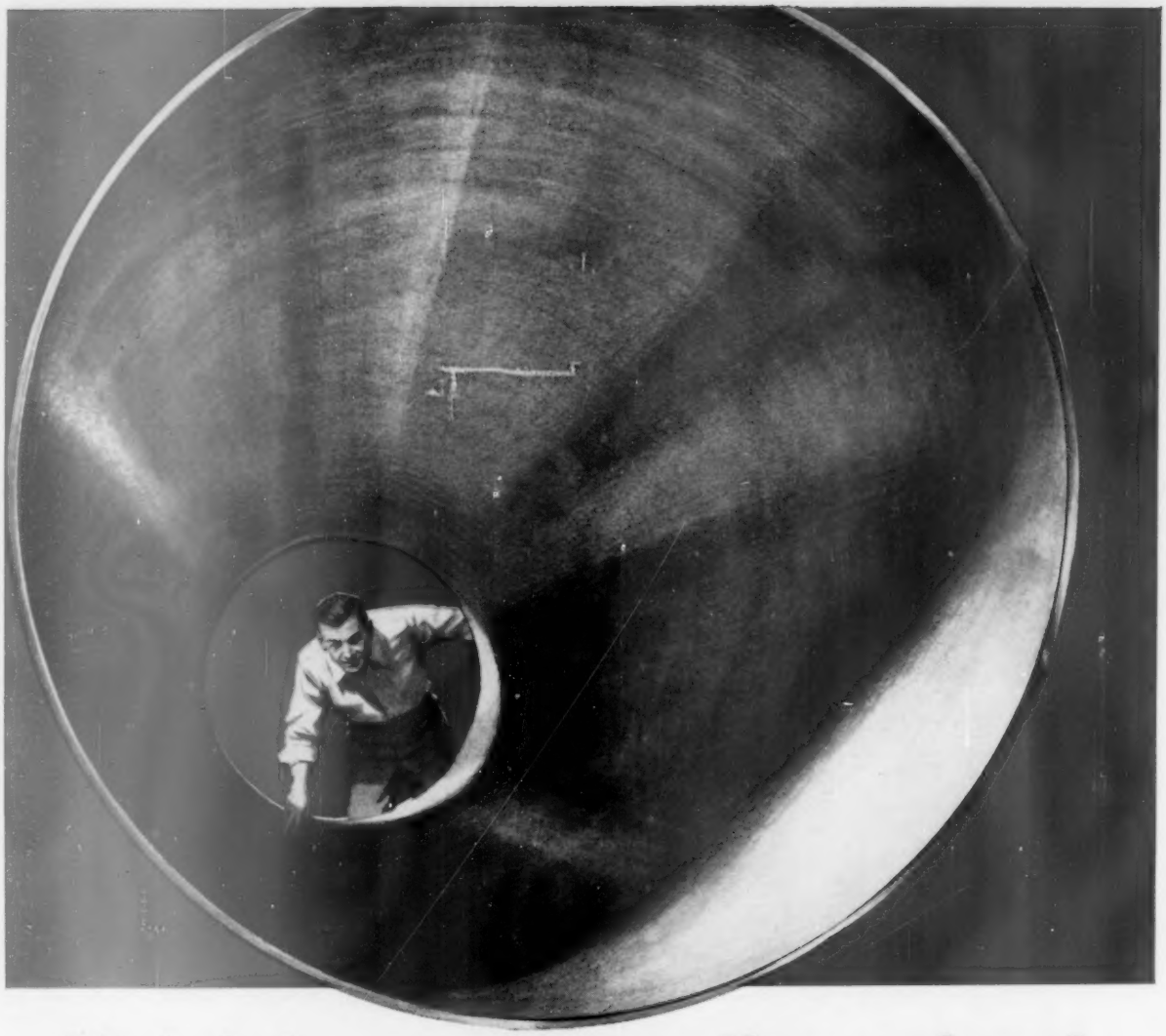
Crude	Products	Gas	Miles	Diam. In.	Location	Cost	HP added last 12 months	HP Planned	Cost
—	—	—	—	—	—	—	900	—	$170,000
—	—	√	292	20, 24, 34	Mexicali to Los Angeles	—	—	10,000	—
—	—	—	—	—	—	—	—	—	—
—	—	√	32	4, 10	Morinville to Westlock Viking San field	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	√	170	—	Montreal to Quebec City	—	—	—	—
—	—	√	9	6	Pana to Assumption, Ill.		—	—	—
—	—	√	12.2	10	Glasford to Canton, Ill.				
—	—	√	50	8	Williamsville to Beardstown, Ill.				
—	—	√	4.5	4	Near Windsor, Ill.				
—	—	√	14.6	6	Replacement from Pana, to Shelbyville, Ill.	$1,894,456			
—	—	—	—	—	—	—	—	—	—
—	—	√	10.9	4, 6, 30	New Line in Barber and Grant counties, Kan.		—	—	—
—	—	√	7.3	4.6	New Line in Nowata and Grant counties, Okla.	—			
—	—	—	—	—	—	—	—	—	—
—	—	√	71	3–8	In the Texas-Louisiana area			12,500	
—	—	√	311	2–12	Ignacio-Blanco area to Climax, Lake County	$7,000,000	—	—	—
—	—	√	140	34	Green River, Wyo., to Provo, Utah		—	—	—
—	—	√	109	26	Texas Panhandle to Southeastern Colo.				
—	—	√	275	6, 30, 34	Southeastern Colo. to Pueblo to Denver to Trinidad, Colo.				
—	—	√	7	20	Bivins to Fourway, Texas				
—	—	√	22.14	4–8	Gathering systems				
—	—	√	48.48	4–12	Gathering systems	—			
—	—	√	402	—	Gubik field to Fairbanks, Alaska	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	10,500	—	$1,647,000
√	—	—	62	10	Ohanet field to In Amenas, Algeria	—	—	—	—
—	—	√	12.6	4	Bondhead to Alliston, Ont., Canada		—	—	—
—	—	√	9.2	30	Peel-Halton town Line to Malton, Ont., Canada	—			
—	—	—	—	—	—	—	12,400	—	$567,876 (combined with Glacier Pipe Line Co.)

PIPELINES BUILT OR UNDERWAY

COMPANY	Crude	Products	Gas	Miles	Diam. In.	Location	Completion	Cost
Cosden Petroleum Corp. Big Spring, Tex.	— √ —	√ — √	— — —	4 8 35.6	3 4 6	Big Spring refinery to Gulf's Coahoma Station Field gathering system For Trust Pipe Line Co.	1960 UC UC	 $602,000
Council for Mutual Economic Assistance (Russia and Satellites)	√	—	—	750	—	Czechoslovakia, Poland and Hungary portions of Comecon system. Russian portion shown under USSR	UC	—
Dixie Pipeline Co. Tulsa, Okla.	—	√	—	1077	6–12	Mont Belvieu, Tex., to Raleigh, N. C.	UC	$43,000,000 (inc. 10 stations, 7 terminals)
East Ohio Gas Co. Cleveland, Ohio	—	—	√	24	26	Portage County to Geauga County, Ohio	UC	—
El Paso Gas Supply Co. El Paso, Texas	—	—	—	—	—	—	—	
El Paso Natural Gas Co. El Paso, Texas	— — — — —	— — — — —	√ √ √ √ √	3.5 18 10.9 37.4 3.09	8 8 16 8 16	EP (NW) 26-in. main line to South Tacoma Mobil Oil Co., Pecos, Texas, to Santa Rosa plant Keystone field to TXL line 30-in. San Juan main line to Snowflake meter sta 16-in. Jal-EP line to near Clint, Texas	11/60 6/61 7/61 UC 6/61	 $8,681,850
Empresa Nacional Calvo Sotelo Madrid, Spain								
Empresa Nacional del Petroleo (Chile) Santiago, Chile	√	—	—	145	—	Magellan fields	1960	—
Esso Sociedad Anonima Petrolera Arg. Buenos Aires, Argentina	√	—	—	394	14	Challaco to Puerto Rosales	UC	—
ENI (Italian Government Agency) Milan, Italy	√	—	—	625	14–26	Genoa, Italy, to Aigle, Switzerland, to Ulm-Ingle-stadt-Stuttgart, Germany	UC	
Equitable Gas Co. Pittsburgh, Pa.	— —	— —	√ √	14.7 5.7	16 20	Blacksville, Monongalia County, W. Va. to Pratt Station, Greene County In Greene County, Pa.	 8/61	 —
Esso Standard (Libya), Inc. New York, N.Y.	√	—	—	100	30	Zelten field to Gulf of Sirte	1961	—
Federated Pipe Lines Ltd. Calgary, Alta., Canada	√ √	— —	— —	41.42 33.5	4–6 16	Miscellaneous gathering systems Fort Assiniboine to Judy Creek	1961 1961	 $1,183,300
Cie. Francaise de Petroles Paris, France	√	—	—	187	8	From Hassi R'Mel to Haoud-el-Hamra station on Hassi Messaoud-Bougie pipeline	UC	—
Gases Naturales de Colombia, S.A. New York, N. Y.	—	—	√	140	10	Cicuco field to Barranquilla	1961	$6,000,000
Gas Trunk Line of British Columbia Ltd. Vancouver, B.C., Canada	—	—	√	45	12, 16	North Jedney field to Beg field to Blueberry field; Boundary Lake to B.C.-Alta. boundary	8/61	$19,100,000 (combined with Saratoga Proc.)
Gaz de France Paris, France	—	—	√	450	3,12	General transportation network	1/61	
Gillette Pipeline Inc. & W. A. Hartwig Inc. Billings, Mont.	—	—	—	—	—	—	—	—
Glacier Pipe Line Co. Ponca City, Okla.	√	—	—	540	3–10	Roundup to Billings to Laurel, Mont., then to Byron, Wyo.; Carway to Cut Bank to Roundup to Ivanhoe to Cat Creek, Mont.; plus central Montana gathering lines	UC	—
Great Northern Pipeline Co. St. Paul 1, Minn.	—	—	—	—	—	—	—	—

PIPELINES PROPOSED OR PLANNED

Crude	Products	Gas	Miles	Diam. In.	Location	Cost	HP added last 12 months	HP Planned	Cost
—	—	—	—	—	—	—	100	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	7,200	—	—
—	—	—	—	—	—	—	—	—	—
—	—	√	228	30	Live Oak County to Sonora, Sutton County, Texas	—	—	—	—
—	—	√	57.2	20	Puckett Line tie-in to Goldsmith plant to Eunice-Plains loop		6,720		$2,335,840
								83,640	$27,645,760
—	—	√	381.4	34	Thistle, Utah, to California-Nevada border				—
—	—	√	118.7	30	Permian-San Juan loop				—
—	—	√	17	30	Pacific Gas Transmission line to Spokane, Washington				—
—	—	√	17.3	4, 8	PGT 36-in. line to Bend and Klamath Falls, Ore.				—
—	—	√	227.6	30	Coquat to Sonora, N. M.				—
—	—	√	210.2	16	Keystone main line station to El Paso, Texas				—
—	—	√	82.6	20, 30, 34	New Mexico loops				—
—	—	√	8.8	12	Skelly plant to Eunice loop line				—
—	—	√	8.2	34	Gallup station to Valve City				—
—	—	√	14.2	6	New line between South Sawyer and Sinclair plant 29				—
—	—	√	61.3	10	From Olympia lateral to Bremerton, Wash.	$61,265,569			—
√	—	—	150	14	Malaga to Puertollano, Spain	$10,000,000	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	√	17.3	20	Greene County, Pa. to Hartson station, Washington County, Pa.	$1,985,000	1,000	—	$415,000
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	$2,319,400	500		$287,300
								500	$319,400
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
√	—	—	102	—	Dead Horse Creek field to Casper, Wyo.	—	—	—	—
—	—	—	—	—	—	—	—	—	—
√	—	—	64	—	Extension to Lignite field, Burke County, N. D.	—	—	—	—



Maintain maximum throughput with Texaco Rust Inhibitors

Texaco Rust Inhibitors keep pipelines completely free of rust and scale. One injection point protects 1,200 miles of line.

Actual in-service tests prove that even after three years of continuous use, pipelines protected by Texaco Rust Inhibitors showed absolutely no signs of corrosion. Only one injection point was needed to protect up to 1,200 miles of line.

Will not react with metals. TRI-182 plates out in an invisible film that protects all metal surfaces through which the inhibited product passes. Oil-soluble and polar by nature, TRI-182 does not react chemically with metals. Neither will it adversely affect the performance of fuels, anti-oxidants, scavengers, inhibitors, dyes, and TEL used in petroleum products.

Protects refinery tankage and tankers. TRI-182 works equally well in protecting refinery tankage and tankers against corrosion. Addition of Inhibitor into refinery blending tankage protects both tankage and line. Flotation method of application is recommended for tankers.

For specifications and details on application, write for Technical Bulletin TRI-182. Address Dept. OGP.

Texaco Inc., *Petrochemical Sales Division*, 135 East 42nd Street, New York 17, N. Y. or 332 South Michigan Ave., Chicago 4, Ill. Dept. OGP.

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TEXACO

PETROCHEMICALS

AQUA AMMONIA, ANHYDROUS AMMONIA, NITROGEN SOLUTIONS, DIISOBUTYLENE, CUMENE, ODORLESS MINERAL SPIRITS, NAPHTHENIC ACID, PROPYLENE TETRAMER, BENZENE, TOLUENE, NAPHTHALENE, RUST INHIBITORS, LUBE OIL AND FUEL ADDITIVES.

Trans-Canada Pipe Lines Limited Chooses Worthington SUTC's . . .

FOR FIRST FULL AUTOMATION

At central control, the dispatcher pushes a button. At the compressor station miles away, a solenoid throws an air valve. Engine and compressor cylinders begin purging . . .

At 6 seconds, ignition actuates, fuel is admitted and the engine slowly accelerates toward 160 rpm. At 20 seconds the compressor cylinders stop purging. In 5 minutes, the engine-compressor is ready to be brought on line.

This is a glimpse of normal operation of Trans-Canada Pipe Lines Limited's Maple Station—the first to be fully automated by this pipeline company. Three Worthington SUTC engine-compressors operate in pre-set sequences according to signals from the dispatcher who, though 25 miles away, could be a thousand.

These new SUTC's have a higher compression ratio for increased efficiency; improved handling of heat load through new computer-designed Turbo-Chargers; and new bearing construction. Cylinder parts and Double Deck valves were manufactured in Canada.

The station organization chart shows the benefit of these automated SUTC's. This station has no operators. This saves initial cost of four houses and salary and overhead for the operators.

For complete information on SUTC's for automated or conventional installations, call your nearest Worthington District Office. Or write Worthington Corporation, Dept. 43-22, Buffalo, New York. In Canada, Worthington (Canada) Ltd., Brantford, Ontario.

WORTHINGTON

PRODUCTS THAT WORK FOR YOUR PROFIT

PIPELINES BUILT OR UNDERWAY

COMPANY	Crude	Products	Gas	Miles	Diam. In.	Location	Completion	Cost
Gulf Refining Co. Houston, Texas	—	—	—	—	—	—	—	—
Houston Natural Gas Corp. Houston, Tex.	— —	— —	√ √	3.70 24.70	4 2–18	Jefferson County, Texas Galveston, Harris, Brazoria, Matagorda, Jackson, Live Oak, Wharton and Ft. Bend counties, Tex.	12/60 11/60–8/61	 $2,750,000
Houston Texas Gas and Oil Corp. St. Petersburg, Fla.	—	—	√	235	2–24	Sales laterals	UC	$16,126,000
J. M. Huber Corp. Borger, Tex.	—	—	√	10	3–8	Field to gasoline plant system	UC	$89,500
Hudson's Bay Oil & Gas Co., Ltd. Calgary, Alta., Canada	—	—	—	—	—	—	—	—
Humble Pipe Line Co. Houston, Tex.	— — √ √ √ √	√ √ — — — —	— — — — — —	11.63 11 5.57 2.59 11.20 4.10	6 4 8 8 12 10	Parks station to Ector-Crane jct. in Texas Baytown to Mont Belview jct. in Texas Bastrop station to Kemper-Satsuma in Texas Johnson station to gate plant C New Quintana to Refugio, Texas New Quintana to Lambert, Texas	2/61 3/61 7/61 8/61 7/61 7/61	 $951,000
Independent Pipe Line Co. Calgary, Alta., Canada	—	—	—	—	—	—	—	—
India Government New Delhi, India	—	—	—	—	—	—	—	—
International Gas Co. Los Angeles, Calif.	—	—	—	—	—	—	—	—
Interprovincial Pipe Line Co. Edmonton, Alta., Canada	—	—	—	—	—	—	—	—
Interstate Oil Pipe Line Co. Shreveport, La.	√ √	—	—	10.5 5.5	4 4	Merit field-Martinville field, Miss. Cecelia field, La., to junction on present system near Breaux Bridge, La.	7/61 UC	— —
Iranian Oil Exploration & Producing Co. The Hague, Netherlands	—	—	—	—	—	—	—	—
Iraq Ministry of Oil Baghdad, Iraq	—	—	—	—	—	—	—	—
Iraq Petroleum Co. London, England	√ √	—	—	530 50	30–32 32	Kirkuk field to Tripoli, Lebanon Offshore in Persian Gulf	UC UC	 —
Israel Government et al Tel Aviv, Israel	—	—	√	17	6	Zohar to Dead Sea	1961	—
Jayhawk Pipeline Corp. Wichita, Kan.	√	—	—	45	3–6	Haskell and Morton counties, Kan.	7/61	$531,000
Kansas-Colorado Utilities Inc. Colorado Springs, Colo.	—	—	—	—	—	—	—	—
Kansas Gas Supply Corp. Oklahoma City, Okla.	— — —	— — —	√ √ √	6.5 16 58	4, 6 4, 6, 8 16	Kingman County, Kan. Commanche County to Barber County, Kan. Sedgwick County to Kiowa County, Kan.	7/61 4/61 —	 —
Kansas-Nebraska Natural Gas Co. Inc. Hastings, Neb.	— — — —	— — — —	√ √ √ √	6.2 17 14.5 10.7	8,10 1¼, 2 1¼, 2 3, 4, 6	To serve fertilizer plant at Hastings, Neb. Almena to Long Island, Kan. To serve field in Red Willow County, Kan. Miscellaneous gathering lines in Colorado, Kansas and Oklahoma	UC 7/61 6/61 1–6/61	 —
Kuwait Oil Co. Ltd. London, England	√	—	—	30	22, 24, 26	Minagish field to Mina al Ahmadi	UC	—

PIPELINES PROPOSED OR PLANNED

Crude	Products	Gas	Miles	Diam. In.	Location	Cost	HP added last 12 months	HP Planned	Cost
√	—	—	—	—	—	—	2,500	—	—
—	—	√	1.20	18	Galveston County, Tex.	$2,750,000	—	—	—
—	—	—	—	—	—	—	30,000	—	—
—	—	—	—	—	—	—	—	—	—
√	—	—	50	4, 8	From Waterton Park-Castle River gas fields to Pincher Creek field to Carway, Alberta	—	—	—	—
—	√	—	270	6, 8, 10	Baytown to San Antonio and Austin, Tex.	—	700	—	$248,000
√	—	—	1073	36	Edmonton, Alta., to Superior, Wis.		—	—	—
√	—	—	946	34	Superior to Montreal				
√	—	—	146	10, 16	Feeder lines from Calgary to Bellshill Lake, Alberta	—			
—	√	—	600	—	Barauni to Delhi		—	—	—
—	√	—	300	—	Bombay to Bhusaval				
—	√	—	420	—	Bombay to Poona to Hyderabad				
—	√	—	350	—	Cochin to Madras				
√	—	—	300	—	Bombay to Bhusaval	—			
—	—	√	1840	30	Reynosa to Mexacali, Mexico	—	—	—	—
√	—	—	90	—	Hamilton, Ont., to Buffalo, N. Y.	—	—	—	—
√	—	—	2.5	4	Garden City field, La., to junction near Franklin, La.		—	—	—
—	√	—	11	6	Baton Rouge, La., to connect with Dixie Pipeline near Baker, La.	—			
√	—	—	52	16, 20	Loops on Agha Jari to Mander Mashur line	—	—	—	—
√	—	—	210	12	Naftkhana to Kirkuk-Tripoli pipeline	$2,800,000	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	√	75	16	To serve power plant at Ashdod Yam	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	√	114	2-6	Hugo to Burlington, Colo.	$951,000	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	√	6	6	Julesburg to Ovid, Colo.	$175,000	5,735	4,575	$1,600,000 $ 600,000
—	—	—	—	—	—	—	—	—	—

PIPELINES BUILT OR UNDERWAY

COMPANY	Crude	Products	Gas	Miles	Diam. In.	Location	Completion	Cost
Lone Star Gas Co. Dallas, Tex.	—	—	√	51.18	18	Palo Pinto to Parker County, Tex.	6/61	
	—	—	√	14.53	8	Carter County, Okla.	6/61	
	—	—	√	6.30	16	Erath to Palo Pinto County, Tex.	6/61	
	—	—	√	23.78	6–10	Wise, Brazos, Eastland; Coke to Runnels Co., Tex.	1960	
	—	—	√	47.50	6–18	Stephens, Rusk, Palo Pinto, Smith counties, Tex.	1961	$7,400,000
Long Island Pipeline Co. (Carl M. Loeb, Rhoades & Co.) New York, N. Y.	—	—	—	—	—	—	—	—
Louisville Gas and Electric Co. Louisville, Ky.	—	—	√	3	4–12	Meade, Johnson, Jefferson counties, Ky.	4–6/61	
	—	—	√	5	8, 20	Hardin, Jefferson and various other counties in Ky.	UC	$400,000
Lo-Vaca Gathering Co. (Coastal States Gas Producing Co.)	—	—	—	—	—	—	—	—
Manufacturers Light & Heat Co. Pittsburgh, Pa.	—	—	—	—	—	—	—	—
Marathon Pipe Line Co. Findlay, Ohio	√	—	—	3.1	12	Lake County, Ind.	12/60	
	√	—	—	9	10	Granville, Ohio	6/61	$511,000
Matador Pipe Line Corp. Denver, Colo.	—	—	—	—	—	—	—	—
Mesa Pipeline Co. Midland, Tex.	—	√	—	55	—	Azalea field in Midland County, Tex.	1960	
	—	√	—	8	—	Connection with Magnolia Pipe Line Co.'s trunk carrier at Midland	—	—
Michigan Wisconsin Pipe Line Co. Detroit, Mich.	—	—	√	20	4	Miscellaneous laterals in Wisconsin and Missouri	8/61	—
Mid-America Pipeline Co. Tulsa, Okla.	—	√	—	106.5	6	Whiting to Ogden, Iowa	10/61	
	—	√	—	14	4	Carson, Winkler, Coke counties, Tex.	7–8/61	
	—	√	—	4.2	6	McPherson County, Kan.	8/61	$1,670,000
Mid-Continent Pipe Line Co. Tulsa, Okla.	—	√	—	16	6	B.A. Knox plant to Velma, Okla.	3/61	
	√	—	—	8.7	6	Criner to Maysville, Okla.	4/61	—
Mid-Saskatchewan Pipe Lines Dept. **Royalite Oil Co., Ltd.** Calgary, Alta., Canada	√	—	—	9.7	2, 3, 4	Gleneath field, Sask., to South Eureka field, Sask.	11/60–6/61	$150,000 (combined with Valley Pipe Line Dept.)
Mobil International New York, N. Y.	√	—	—	321	30	Ohanet field, French Sahara, to Hassi Messaoud	1961	—
Montana-Dakota Utilities Co. Minneapolis, Minn.	—	—	—	—	—	—	—	—
Montana Power Co. Butte, Mont.	—	—	√	82	16	Carway, Alta., Canada, to Cut Bank, Mont.	1961	—
Monterey Gas Transmission Co. Houston, Tex.	—	—	—	—	—	—	—	—
Mountain Fuel Supply Co. Rock Springs, Wyo.	—	—	√	104	20	Uinta Basin to Clear Creek, Utah	UC	—
Mustang Fuel Corp. Oklahoma City, Okla.	—	—	√	77	12	Gathering lines in Canadian, Dewey and Blaine counties, Okla.	UC	—
National Iranian Oil Co. Tehran, Iran	—	√	—	360	8	Rey to Meshed, Iran	—	—
Soc. Nationale des Petroles d'Aquitaine Algiers, Algeria	—	—	—	—	—	—	—	—
The National Pipe Line Co. (subsidiary of F. H. McGraw & Co.) New York, N. Y.	—	√	—	55	—	Escanaba, Mich., to K. I. Sawyer AFB near Sands in Upper Peninsula	UC	$1,300,000

PIPELINES PROPOSED OR PLANNED

Crude	Products	Gas	Miles	Diam. In.	Location	Cost	HP added last 12 months	HP Planned	Cost
		√	27.04	6, 8	Knox County to King County, Tex.; and in Stephens County, Tex.	$478,000	1,320	2,000	$450,653 $627,432
—	√	—	75	20	Linden, N. J., across Staten Island, under The Narrows waterway to Brooklyn and LaGuardia and Idlewild Airports	$30,000,000	—	—	—
—	—	—	—	—	—	—	1,100	—	$225,000
—	—	√	286	6-20	Live Oak County to Lavaca County	—	—	—	—
—	—	√	10.5	24	Allegheny, Washington, Beaver counties, Pa.	—	4,000	—	$2,387,000
√	—	—	30	—	Extensions	$650,000	2,450	400	$160,000 $ 42,000
√	—	—	175	—	Cromer, Man., Canada, to Burke, Bottineau and Renville counties, N. D.	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	√	26	30	Loop in Michigan	$2,800,000	12,000	3,000	$4,000,000 $1,400,000
—	√	—	108	6	Ogden, Iowa to Charles City, Iowa	$1,900,000	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	√	106	12	Minot to Bismarck, N. D.		800	298	$231,223 $ 71,060
—	—	√	14	8	Tioga to McGregor, N. D.				
—	—	√	29	4, 6	Williston main line to Alexander to Watford City, N. D.				
—	—	√	22	2	Lateral line extensions in North Dakota				
—	—	√	22	3	Lateral line extensions in North Dakota	$4,092,535			
—	—	—	—	—	—	—	—	—	—
—	—	√	216	30	Clear Lake, Tex., to Alexandria, La.	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
√	—	—	146	6	Azna to Isfahan, Iran	—	—	—	—
√	—	—	75	10	El Agreb and El Gassi fields to Hassi Messaoud-Bougie pipeline	—	—	—	—
—	—	—	—	—	—	—	—	—	—

PIPELINES BUILT OR UNDERWAY

COMPANY	Crude	Products	Gas	Miles	Diam. In.	Location	Completion	Cost
Natural Gas Pipeline Co. of America Chicago, Ill.	—	—	√	371.2	30	Wharton, Fort Bend, Harris, Polk, Angelina, Nacogdoches and Cass counties, Tex.; Miller, Hempstead, Pulaski, White, Lonoke, Independence and Jackson counties, Ark.; Stoddard, Bollinger and Cape Girardeau counties, Mo.; Shelby, Moultrie and Piatt counties, Ill.	11-12/60	
	—	—	√	144.5	6, 8, 10, 20	Brazoria, Galveston, Aransas, Refugio, Jim Hogg, Brooks, Duval and Bee counties, Tex.	10-12/60 3-4/61	
	—	—	√	63.05	36	Meade, Clark, Ford, Cloud and Republic counties, Kan.; Mahaska County, Iowa	UC	
	—	—	√	27.39	30	Piatt and McLean counties, Ill.	UC	—
New York State Natural Gas Corp. Pittsburgh, Pa.	—	—	√	7.65	30	Berger compressor station to Dryden, Tompkins County, N. Y.	UC	
	—	—	√	50	4-10	Production lines in Madison, Livingston, Wyoming counties, N. Y. and Cameron, Clearfield, Elk, Jefferson counties, Pa.	UC	—
Niagara Mohawk Power Corp. Syracuse, N. Y.	—	—	√	13	16	Oneida to Rome, N. Y.	UC	$1,000,000
Northern Alberta Pipelines, Ltd. Edmonton, Alta., Canada	—	—	—	—	—	—	—	—
Northern Gas Products Co. Omaha, Neb.	—	—	—	—	—	—	—	—
Northern Natural Gas Co. Omaha, Neb.	—	—	√	65.5	16	Duluth to Silver Bay, Minn.	8/61	
	—	—	√	82.5	20	Menominee, Ill. to Janesville, Wis.	UC	
	—	—	√	124.3	26	Ogden, Iowa to east of Waterloo	UC	
	—	—	√	20.4	24	Near Hooper, Neb.	UC	
	—	—	√	11.1	24	Near Paullina, Iowa	UC	
	—	—	√	13.7	30	Near Ventura, Iowa	UC	
	—	—	√	9.2	30	Near Ogden, Iowa	UC	
	—	—	√	10.9	30	Near Beatrice, Neb.	UC	
	—	—	√	5.7	30	Near Mackville, Kan.	UC	
	—	—	√	15.6	30	Near Beaver, Okla.	UC	
	—	—	√	116.6	2-8	Central Minnesota	8/61	
	—	—	√	138.5	2-8	Southeastern Minnesota	8/61	
	—	—	√	131.8	2-10	Eastern Iowa	8/61	
	—	—	√	130.7	2-8	Southwest Iowa	8/61	
	—	—	√	296.3	2-8	Central Iowa	8/61	
	—	—	√	175.7	2-8	Northwest Iowa	8/61	
	—	—	√	116.5	2-8	Eastern South Dakota	8/61	$105,000,000
Northwestern Refining Co. St. Paul, Minn.	—	—	—	—	—	—	—	—
Oasis Group (Ohio Oil, Amerada, Continental) with Esso Sirte, Libyan-Amer.	√	—	—	90	30	Dahra area of Libya to Es Sider on Gulf of Sirte	UC	—
The Ohio Fuel Gas Co. Columbus, Ohio	—	—	√	2	18	Meigs, Athens, Hocking counties, Ohio	6/61	
	—	—	√	1	8	Muskingum and Guernsey counties, Ohio	6/61	
	—	—	√	10	3, 12	Wayne, Stark and Richland counties, Ohio	1960-61	$590,950
Oil India Limited (Burmah Oil, Assam Oil, India Government)	√	—	—	720	14, 16	Nahor to Noonmati to Barauni	UC	—
Okaloosa County Gas District Valparaiso, Fla.	—	—	√	33	10	Milton to Ft. Walton Beach, Fla.	UC	$675,000
Okan Pipe Line Co. Tulsa, Okla.	—	√	—	—	—	—	—	—
Oklahoma Illinois Gas Pipeline Co. (Fish Engineering Corp. and Pan American Petroleum Corp.)	—	—	—	—	—	—	—	—
Olympic Pipeline Co. Seattle, Wash.	—	—	—	—	—	—	—	—
Pacific Gas & Electric Co. San Francisco, Calif.	—	—	√	297	36	New line from Oregon border to Antioch	UC	
	—	—	√	9	12	Loop line from Berenda to Chowchilla	12/60	
	—	—	√	15	3-8	Collection lines	1961	$61,934,498

PIPELINES PROPOSED OR PLANNED

Crude	Products	Gas	Miles	Diam. In.	Location	Cost	HP added last 12 months	HP Planned	Cost
—	—	√	259	30	Victoria, Wharton, Montgomery, Liberty, Panola, and Harrison counties, Tex.; Clark, Grant and Lawrence counties, Ark.; Washington, Marion, Clinton, McLean and Livingston counties, Illinois.	—	8,800	—	—
—	—	√	23.2	12	Existing 14-in. line at Aurelius, N. Y., to connection with N. Y. State Electric & Gas Corp., Phelps, N. Y.	—	5,000	4,000	—
—	—	√	128	6, 12	Watertown to Malone, N. Y.	$6,500,000	—	—	—
—	—	√	110	—	Lac La Biche to Edmonton	—	—	—	—
—	√	—	350	8	Bushton, Kan., to Des Moines, Iowa	$12,000,000	—	—	—
—	—	—	—	—	—	—	18,200	—	$6,500,000
√	—	—	—	—	Gathering system in Rival and Lignite fields, Burke County, N. D.		—	—	—
			—	—	Gathering system in Glenburn field, Renville County, N. D.	—			
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	1,100	—	$160,000
—	—	√	550	—	Woodward, Okla., to St. Louis, Mo., and across Mississippi River to serve western Illinois.	—	—	—	—
—	√	—	324	6–16	From Ferndale and Anacortes, Wash., to Seattle and Portland	—	—	—	—
—	—	√	67	20	Kettleman to Morro Bay		8,245	—	$4,050,000
—	—	√	56	6–20	Canadian Main 400 to Redding, Andersen and Calaveras Cement Co.; and from Buckeye-Grimes field to Canadian Main 400				
—	—	√	44	36	Loop line from Antioch to Irvington				
—	—	√	99.5	3–30	Collection lines	$19,176,186			

PIPELINES BUILT OR UNDERWAY

COMPANY	Crude	Products	Gas	Miles	Diam. In.	Location	Completion	Cost
Pacific Gas Transmission Co. San Francisco, Calif.	—	—	√	611	36	Canada-Idaho border to the Oregon-California border	1961	$121,165,000
Pakistan Industrial Development Corp. Karachi, Pakistan	—	—	—	—	—	—	—	—
Pan American Gas Co. Tulsa, Okla.	—	—	√	50	—	Texas City to Pasadena and La Porte, Tex.	1961	—
Panhandle Eastern Pipe Line Co. Kansas City, Mo.	— —	— —	√ √	259 76	4–12 4, 6, 8	Gathering facilities in Oklahoma, Tex. and Kan. Gathering facilities in St. Clair, Mich.	1–7/61 2/61	 $3,000,000 (combined with Anadarko Production Co.)
Peace River Oil Pipe Line Co., Ltd. Calgary, Alta., Canada	√	—	—	161	12	From Fox Creek, Alta. to Edmonton, Alta.	10/61	$15,000,000
The Peoples Natural Gas Co. Pittsburgh, Pa.	— — — — —	— — — — —	√ √ √ √ √	2 1.5 18.2 8 1.5	12 12 24 12 12	Vicinity of Wall station in Pa. Vicinity of Monroeville Boro, Pa. From Crayne farm to Gibson station, Pa. From Aliquippa to Midland, Pa. From King farm to Gibsonia, Pa.	12/60 8/61 UC UC 7/61	 —
Petrogas Processing Co., Ltd. Calgary, Alta., Canada	√	—	—	208	—	Gathering system in vicinity of Balzac, Alta.	10/61	—
Petroleo Brasileiro S. A. Rio de Janeiro, Brazil	—	—	—	—	—	—	—	—
Petroleos Mexicanos Mexico, D. F., Mexico	—	—	—	—	—	—	—	—
Phillips Petroleum Co. Bartlesville, Okla.	— √ √	√ — —	— — —	27 32 59	12 6, 8 3, 4, 6	Hutchinson County to Hansford County, Tex. Ochiltree County to Hutchinson County, Tex. Beaver County, Okla. and Ochiltree County, Tex.	6/61 7/61 8/61	 —
Phillips Petroleum Co. (partner with Sunray Mid-Continent, Ashland Oil & Refining, Kerr-McGee Oil Ind., El Paso Natural Gas, Western Natural Gas, Pacific Petroleum Ltd. subsidiaries)	√	—	—	42	24	From Venezuela's Morichal field in southern Monagas State to near Puerto Ordaz	8/61	$15,000,000
Piedmont Natural Gas Co. Inc. Charlotte, N. C.	—	—	√	2.21	10	Charlotte border station to Sunset Road regulator station, N. C.	1960	$107,000
Pioneer Natural Gas Co. Amarillo, Tex.	— — — —	— — — —	√ √ √ √	41.47 1.62 1.47 40	3–10 6 3 2	Fritch-Turkey Creek gathering system in Tex. Pan American plant to Ropes 4-in. line Near Owens Gin Amarillo gathering to trunk line	UC 4/61 3/61 3/61	 —
Pipelines of Puerto Rico San Juan	—	√	—	95	8	Penuelas to Catano	UC	—
Plateau Natural Gas Co. Colorado Springs, Colo.	—	—	—	—	—	—	—	—
Potomac Public Service Co. Arlington, Va.	—	—	—	—	—	—	—	—
Public Service Co. of North Carolina Gastonia, N. C.	—	—	√	17	14	Stem to Roxboro	1961	—
Pure Transportation Co. Palatine, Ill.	√	—	—	10.13	2–4	Miscellaneous locations in Illinois	UC	$36,000
Qatar Government Doha, Qatar	—	—	√	60	6, 10	From Dukhan to Doha	3/61	—
Quebec Gas Transmission Lines, Inc. Montreal, Canada	—	—	—	—	—	—	—	—
Rangeland Pipe Line Div., Hudson's Bay Oil and Gas Co., Ltd. Calgary, Alberta, Canada	√ √ √ √ √ √	— — — — — —	— — — — — —	7.8 2.6 12.2 31.2 3.3 10.9	4 2 3 2, 4 4 4	Gathering additions Gilby gas plants to R. P. L. trunk line Leafland to Medicine River Wimborne to Innisfail Sylvan Lake area to R. P. L. trunk line Caroline area to Garrington	10/61 12/60 6/61 6/61 UC UC	 $1,045,000

PIPELINES PROPOSED OR PLANNED

Crude	Products	Gas	Miles	Diam. In.	Location	Cost	HP added last 12 months	HP Planned	Cost
—	—	—	—	—	—	—	26,000	—	—
—	—	√	1000	—	Sui gas field to Lyallpur, Lahore, Rawalpindi and Wah	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	√	205	22, 24	Elk City, Okla. to Haven, Kan.		2,500		$650,000
—	—	√	80	6–12	Missouri, Illinois, Indiana, Michigan			29,200	$9,755,000
—	—	√	316	26, 30	Oklahoma, Kansas, Missouri and Illinois	$47,731,000			
—	—	—	—	—	—	—	—	—	—
—	—	√	2	12	Vicinities of Plum Boro and Penn Hills Boro, Pa.	—	—	—	—
—	—	—	—	—	—	—	—	—	—
√	—	—	298	12	Rio de Janeiro to Belo Horizonte, Brazil		—	—	—
√	—	—	80	24	Agua Is., Guanabara Bay, near Rio de Janeiro, to Duque de Caxias refinery	—			
—	—	√	332	10	Queretaro to San Luis; Salamanca to Lagos-Guadalajara, Mexico		—	—	—
√	—	—	291	16, 18	Minatitlan to Salina Cruz; Poza Rica to Tampico, Mexico				
—	√	—	497	12	Ciudad Pemex to Mexico City	$30,000,000			
—	—	—	—	—	—	—	6,350	—	—
—	—	—	—	—	—	—	—	—	—
—	—	√	6.37	6, 10	Near High Point and Charlotte, N. C.	$221,200	—	—	—
—	—	√	27	3, 8, 10	Felmac gathering system to Gaines County, Tex.		—	—	—
—	—	√	4	20	Martin County, Tex.				
—	—	√	24	20	Potter and Randall counties, Tex.				
—	—	√	7	6	Potter County, Tex., to Helium line	—			
—	—	—	—	—	—	—	—	—	—
—	—	√	14	4	Manitou Springs to Woodland Park, Colo.	$850,000	—	—	—
—	√	—	80	—	Curtis Bay area south of Baltimore, Md., to Dulles Internationa Airport at Chantilly, Va.	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	√	300	—	Quebec to Montreal	—	—	—	—
√	—	—	11	4	Waterton to Pincher Creek		—	1,000	$274,000
√	—	—	30	8	Pincher Creek to Carway	$1,600,000			

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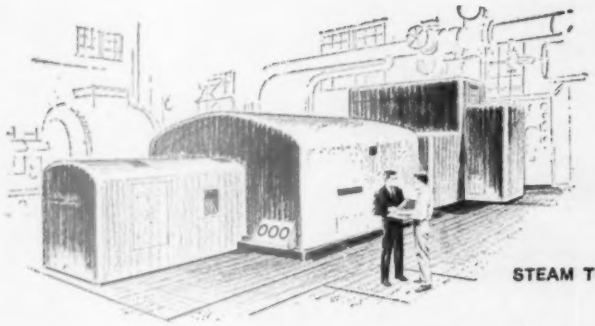
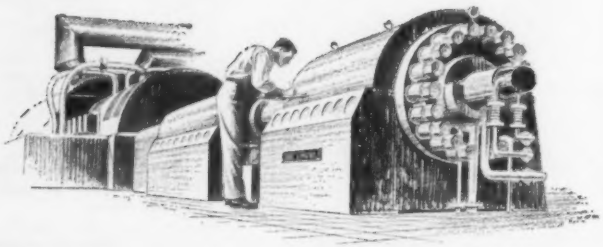
engineered dependability has helped keep America strong for 60 years

Since 1901, De Laval has helped keep America strong by supplying high-quality, precision-built equipment to almost every industry and service. In refineries . . . power plants . . . steel mills . . . mines . . . waterworks . . . pipelines . . . paper mills . . . the armed forces and the merchant marine, De Laval's engineered dependability has helped strengthen our country's economy and defenses for 60 years.

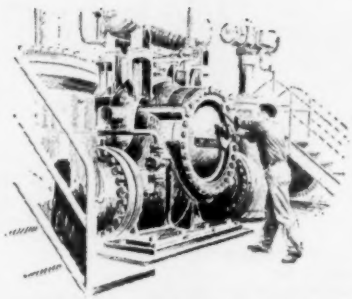
De Laval Steam Turbine Company, Trenton 2, N. J.



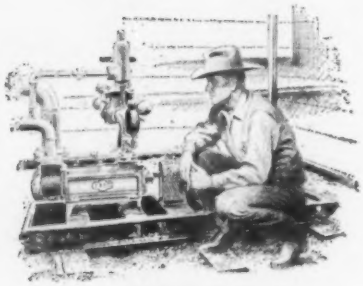
STEAM TURBINES



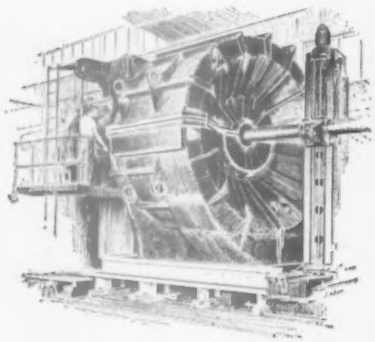
CENTRIFUGAL PUMPS



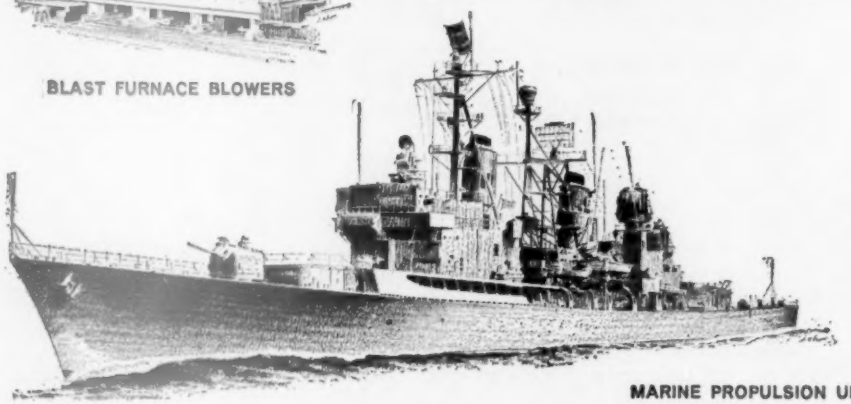
SINGLE- AND MULTI-STAGE COMPRESSORS

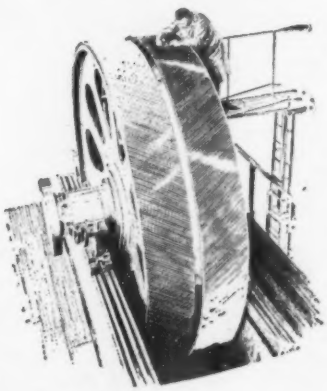


IMO® ROTARY PUMPS



BLAST FURNACE BLOWERS





MARINE PROPULSION UNITS AND AUXILIARIES

MG-DL-112

DE LAVAL • 60 YEARS OF CREATIVITY AND QUALITY

CENTRIFUGAL PUMPS AND COMPRESSORS • TURBINES • IMO® ROTARY PUMPS AND HYDRAULIC MOTORS
MARINE PROPULSION AND AUXILIARY EQUIPMENT • HELICAL AND EPICYCLIC GEARS • TURBOCHARGERS

X-TRU-COAT BRINGS GAS TO OSAGE

...contractor says,
"Best pipe I've ever installed!"

PRINCIPALS in the Osage installation, left to right, John Mathews, Panama Williams Company, contractors; Augie Stricker, consulting engineer; Mayor Urban Marr; Donald Stuart, consulting engineer. Not shown is Joseph E. Casey, Vice President of Carlton D. Beh Company, the underwriters of the revenue bonds used to finance the Osage system. Total of X-TRU-COAT Pipe, installed in 1" to 8" diameters, is expected to reach 180,000 feet.

After welding, X-TRU-COAT Pipe joints are primed and wrapped with X-TRU-TAPE, sealing out corrosion. When welds are completed, the pipe is pulled back, lowered, and slid under drives and walks without damage.

Strong, Modern, Dependable

Steel

X-TRU-COAT BRINGS GAS TO OSAGE

Citizens of Osage, Iowa, who until this year did not have the advantages of natural gas for cooking and heating, have good reason to be elated. Natural gas is coming to Osage! Carried to homes and industry via more than 34 miles of X-TRU-COAT Pipe, the natural fuel is expected to reduce heating costs at least 25%, and cooking costs by 50%. Mayor Urban Marr and his city council are elated too, at the success of their efforts to obtain this community improvement.

John Mathews, of Panama Williams Company, contractors installing the gas system in Osage, is elated for another and very different reason. He has this to say: "I've used X-TRU-COAT on many jobs and without a doubt it is the best pipe I've ever installed. It's very easy to handle and store, and you don't have to worry about heat or cold, coating breaks, or holidays."

Mr. Mathews says further that the Osage installation is typical of many installations, in that pipe must be slid through tunnels dug beneath driveways and sidewalks—and that he has found that X-TRU-COAT will not check, scratch, or tear, even in rocky soil. X-TRU-COAT's polyethylene plastic coating, in Mr. Mathews' words, "is there to stay." Even abuse in stringing or backfilling won't damage it.

All of which means that X-TRU-COAT will fully support Osage's efforts, and the efforts of any community, with savings in original installation and dependability in service—every foot usable when received—every foot easy to install, perfectly—every foot permanently sealed against corrosion and electrolytic action, for long, long service.

Republic is proud to have shared in bringing gas to Osage. If *you* are interested in a similar project, or if you are considering an industrial use of pressure carrying line pipe, call your Republic distributor. He can cite many case histories illustrating the remarkable durability and economy of X-TRU-COAT.

REPUBLIC STEEL

REPUBLIC HAS THE FEEL FOR MODERN STEEL

REPUBLIC STEEL CORPORATION
DEPT. PL-2693
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☐ Please send .... reprints of "The Osage Story."
☐ Have a Republic distributor call.
☐ Please send literature on X-TRU-COAT Plastic Coated Steel Pipe.

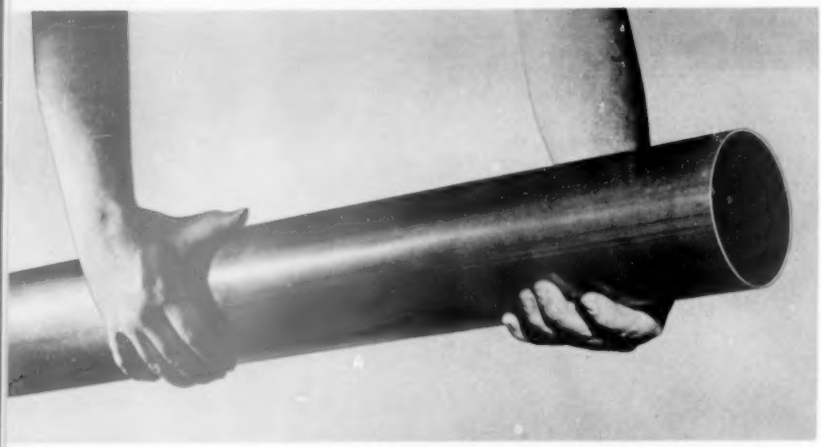
Name_____ Title_____

Company_____

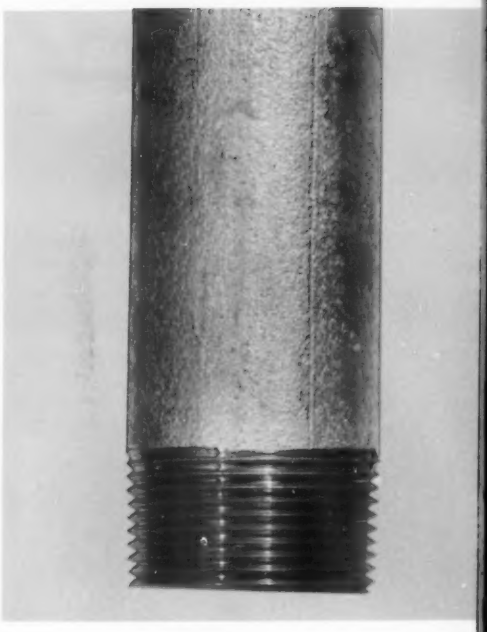
Address_____

City_____ Zone____ State_____

REPUBLIC SRK® PLASTIC PIPE has won big acceptance as "the pipe you can put in and forget." For gas, saltwater, and other corrosive materials, SRK resists every destructive action. Available in half-inch through eight-inch diameters, for a wide range of pressures.



REPUBLIC LIGHT WALL, the electric weld pipe that's ideal for gathering and distribution lines. Saves ⅓ the weight, ⅓ the cost. X-TRU-COAT is also available in light wall sizes. Meets applicable parts of API specification 5L . . . supplied in sizes from 1.315" through 4.500" O. D.



REPUBLIC STEEL PIPE, choice of operating men for tough jobs. Tight galvanized coating stubbornly resists corrosion damage. For water, gas, and steam systems—black and galvanized—delivered clean, rust-free, on time.

REPUBLIC STEEL CORPORATION
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Please send literature on:

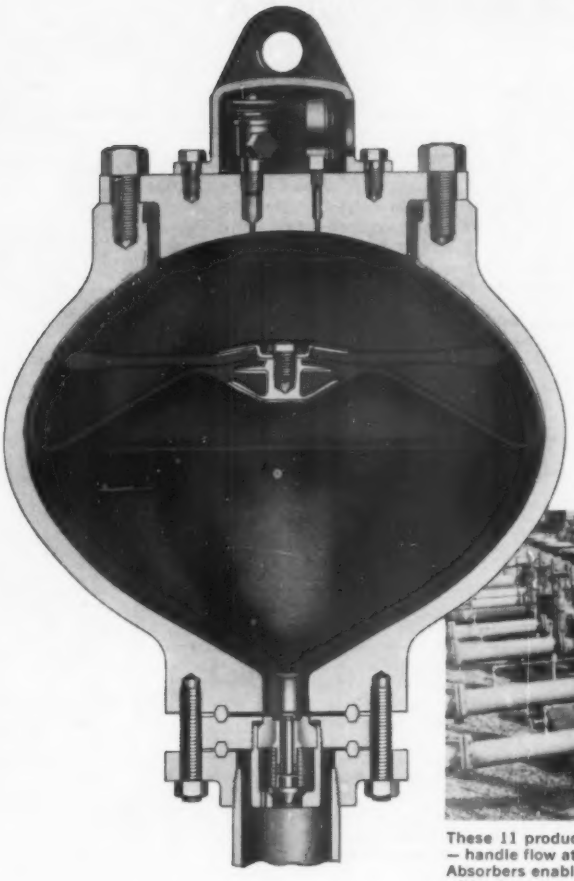
☐ Republic X-TRU-COAT ☐ Republic SRK Plastic Pipe
☐ Republic Light Wall Pipe ☐ Republic Steel Pipe

Name_____ Title_____

Company_____

Address_____

City_____ Zone____ State_____



prolongs life of pipelines, fittings and pumps... saves downtime... cuts maintenance costs!

These 11 product transfer lines — some over 1,000 feet long — handle flow at the rate of 1,600 gpm each, yet Hydril Surge Absorbers enable them to be closed in a fraction of a second without over-pressuring lines, fittings or metering equipment.

HYDRIL TYPE "K" SURGE ABSORBER

smooths out shock and pulsation in pipelines

QUICK-CLOSING VALVES and piston-type pumps punish pipelines by imposing sudden peak pressure loads. Unless these surges can be absorbed or smoothed out, pipe and fittings are exposed to stresses which may cause costly failure.

Hydril Type "K" Surge Absorbers are successfully controlling many types of line surge and pulsation in petroleum product handling lines, water pumping systems and oilwell repressuring programs. Simple design and construction assures long, trouble-free operation. This same oil field-proven Hydril design has been used for many years as a pulsation dampener on high-pressure oilwell mud pumps. Servicing, though rarely required, is readily performed without special tools and without shutting down the system or removing the unit from the line. Available in a wide range of sizes and pressure ratings.

Another dependable Hydril pressure-control product

For more detailed information on Hydril Surge Absorbers, consult your Pipeline or Composite Catalog . . . or call your Hydril Representative

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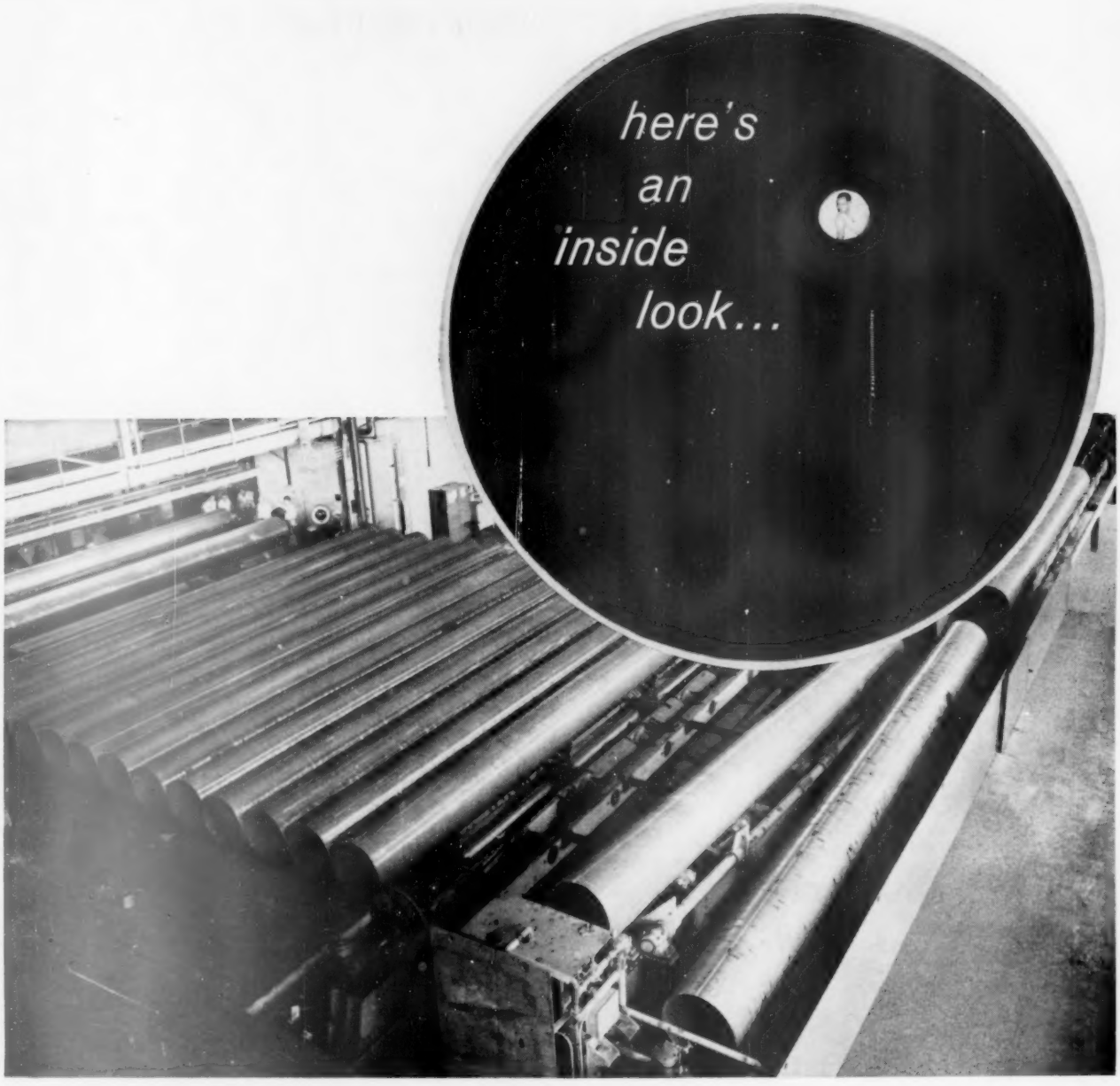
PIPELINES BUILT OR UNDERWAY

COMPANY	Crude	Products	Gas	Miles	Diam. In.	Location	Completion	Cost
Richfield Oil Corp.	—	—	√	26	12	Los Angeles to Wilmington, Calif.	7/61	
Long Beach, Calif.	√	—	—	5	6	Los Angeles, Calif.	7/61	$2,000,000
Rio Grande Valley Gas Co.	—	—	√	9	6, 8	Northwest Hidalgo County, Tex.	5/61	
Brownsville, Tex.	—	—	√	8	2–6	Zapata County, Tex.	8/61	
	—	—	√	3	6	Starr County, Tex	8/61	$250,000
Royal Dutch/Shell Group								
The Hague, Netherlands	—	—	—	—	—	—		
Rock Island Oil & Refining Co.								
Wichita, Kan.	√	—	—	60	6, 7	Red Willow County, Nebr., to Colby, Kan.	1961	—
Saratoga Processing Co. Ltd.								
Calgary, Alta., Canada	—	—	√	59	4, 10, 16	Coleman, Alta., to Savanna Creek field	8/61	—
Saskatchewan Power Corp.	—	—	√	35.22	4, 6	Preeceville to Canora	UC	
Regina, Sask., Canada	—	—	√	10.57	4	New lines in the areas of Fort San and Bishopric	6/61	
	—	—	√	8.0	3, 6	New lines in Hoosier and Many Islands	11/60	
	—	—	√	83.18	2, 4	Miscellaneous laterals	1960/61	$3,497,377
Scottish Gas Board								
Glasgow, Scotland	—	—	—	—	—	—	—	—
Seadrift Pipe Line Co.								
Corpus Christi, Texas	—	√	—	121	6	Kingsville to Brownsville, Tex.	UC	—
Service Pipe Line Co.	√	—	—	61	12	La Plata, Mo. to Wood River, Ill.	7/61	—
Tulsa, Okla.	√	—	—	3	12, 16	Arkansas River crossing in Oklahoma	4/61	—
Shoshone Pipeline, Ltd.								
Cody, Wyo.	—	√	—	96	6	Cody, Wyo. to Billings, Mont.	1960	—
Sinclair Pipe Line Co.								
Independence, Kan.	√	—	—	170	8	Stockholm to Panova, Okla.	9/61	—
Skelly Oil Co., Pipe Line Dept.	√	—	—	10.5	3, 8	S. Central Kansas	7/61	
Tulsa, Okla	√	—	—	12	3, 6	S. Central Kansas	1960	—
Soc. Siciliani Metandotti								
Rome, Italy	—	—	—	—	—	—	—	—
Sinclair Venezuelan Oil Co.								
Caracas, Venezuela	—	—	—	—	—	—	—	—
Sohio Petroleum Co.								
Cleveland, Ohio	√	—	—	5.7	4	North end of Sohio line in Jefferson Davis Parish, La., to The Union Texas Natural Gas Co. line in Jefferson Davis Parish, La.	1/61	$365,000 (combined with Sohio Pipe Line Co.)
Sohio Pipe Line Co.								
Cleveland, Ohio	—	√	—	2.52	6	Medway station, Clark County, Ohio to Wright-Patterson AFB.	9/60	—
South Alberta Pipe Lines Ltd.								
Calgary, Alta., Canada	—	—	√	1.25	3	Gathering Lines	10/61	$16,000
South Carolina Natural Gas Co.								
Columbia, S. C.	—	—	√	4	10	McMeekin station to National Aniline Co.	7/61	$133,500
Southern Pacific Pipe Lines, Inc.								
San Francisco, Calif.	—	√	—	70	8	Stockton to Atwater, Calif.	—	—
South European Pipeline Co. (Shell, Jersey Standard, Caltex, British Petroleum, et al)	√	—	—	459	30	Lavera, France, to Strasbourg, France, and Karlsruhe, Germany	UC	
South Georgia Natural Gas Co.	—	—	√	1.27	3	From original 12-in. line to Lumpkin, Ga.	11/60	
Thomasville, Ga.	—	—	√	34.02	6	From original 10-in. line to north of Tifton, Ga.	11/60	
	—	—	√	24.29	4	From end of 6-in. line north of Tifton to north of Ocilla, Ga.		
	—	—	√	6.16	3	From end of a 4-in. line north of Ocilla to Fitzgerald, Ga.	11/60	
	—	—	√	2.08	4	From north of Tifton to Tifton	11/60	
	—	—	√	13.37	3	Worth County to Ashburn, Ga.	11/60	
	—	—	√	31.44	3, 4, 6	From original 10-in. line to Nashville, Ga.	11/60	$1,941,960

PIPELINES PROPOSED OR PLANNED

Crude	Products	Gas	Miles	Diam. In.	Location	Cost	HP added last 12 months	HP Planned	Cost
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	300	400	$50,000 $70,000
√	—	—	160	20	Tandjung oil field, South Borneo, Indonesia, to Balikpapan refinery	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
— —	— —	√ √	88 2.18	14 2	Hatton to Success, Sask. New lines in Preeceville, Stenen, Sturgis	—	7,000	—	$2,197,855
— —	— —	√ √	21 23	— —	Grangemouth to Edinburgh Azmadale to Falkirk	$2,800,000	—	—	—
—	—	—	—	—	—	—	—	—	—
√ √	— —	— —	50 16	8 12	La Barge to Granger, Wyo. Crete to Blue Island, Ill.	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	√	—	3	8	At Paulsboro, N. J.	—	400	990	—
—	—	—	—	—	—	—	—	—	—
—	—	√	637	—	From Hassi R'Mel field Algeria, to Cape Bon, Tunisia, across Mediterranean to Sicily and into Italy	—	—	—	—
√	—	—	17	8	East Aguasay to south bank of Tonoro River	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	370	—	$150,000
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	—
√	—	—	155	22	Karlsruhe, Germany to lower Batavia	—	—	—	—
— —	— —	√ √	1.30 1.20	3 3	From 4-in. line in Irwin County to Ocilla, Ga. From 6-in. line in Worth County to Sylvester, Ga.	$30,000	—	—	—



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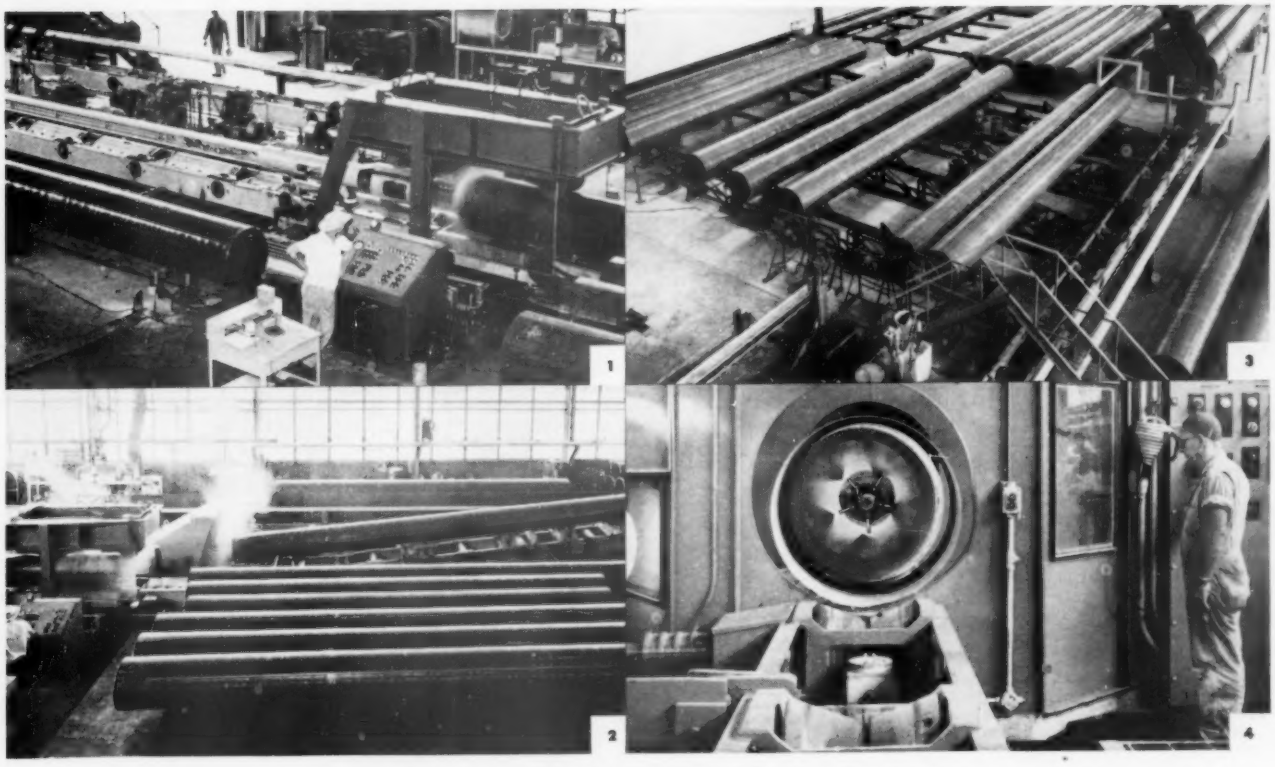
Pipe coating equipment of a completely new design all under one roof! At Houston as well as Milwaukee you can take advantage of internal coating of 16″ through 36″ line pipe to your specifications — the complete automated process takes place in fully enclosed buildings supervised by expert A. O. Smith personnel.

And as in Milwaukee, equipment and operations have been specially designed to give particular attention to the cleaning and preparation of the pipe surface prior to actual coating. This follows A. O. Smith's belief that the best coating results are obtained from an originally clean, pickled surface, and that coating applied to such a surface will yield maximum benefits to the user.

industry's most modern internal coating facilities at A. O. Smith Houston plant



ALL UNDER ONE ROOF

1 DOUBLE SCRUBBING — Pipe is brushed on both forward and reverse cycles. On the forward cycle the pipe is wire brushed with a hot detergent solution. On the reverse cycle a clear hot water spray is used.

2 HOT RINSING — Water heated to 180° is used for the wash out operation. Pipe is elevated to drain rinse water while heated air is blown through to speed drainage and drying.

3 CONVEYING AND DRYING — After completion of the hot rinsing and wash out operation, the pipe dries as it is slowly conveyed to a holding station just outside the coating area.

4 COATING — Airless spray equipment applies the coating within an 8'x8', dust-free steel enclosure. The entire coating area is separated from the rest of the mill by an "air curtain" created through pressure reduction.

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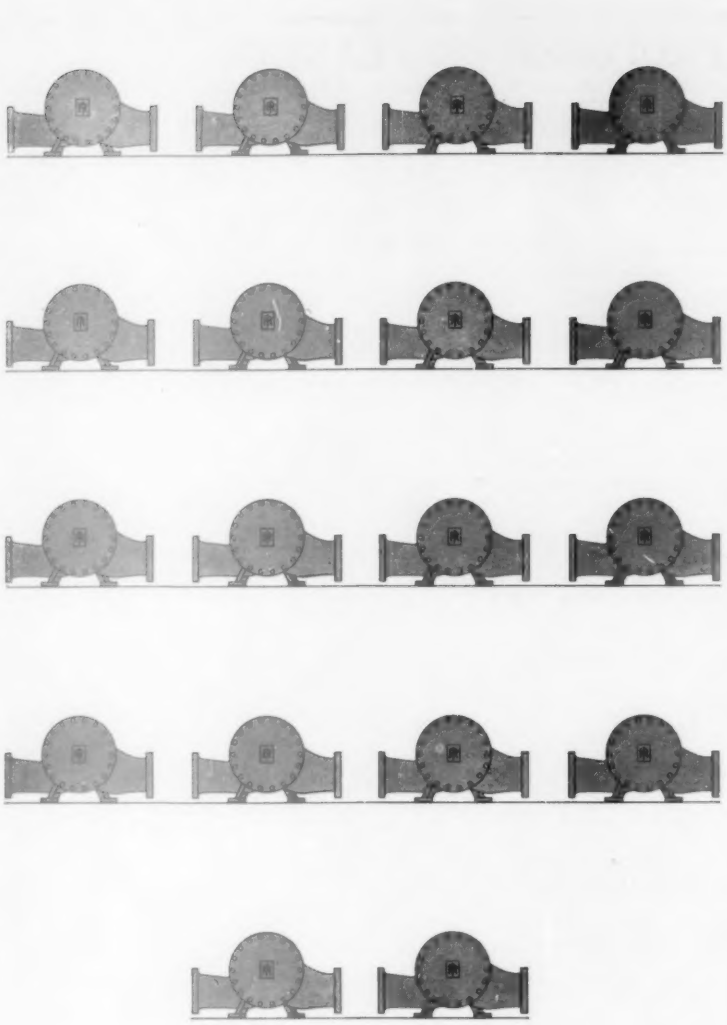
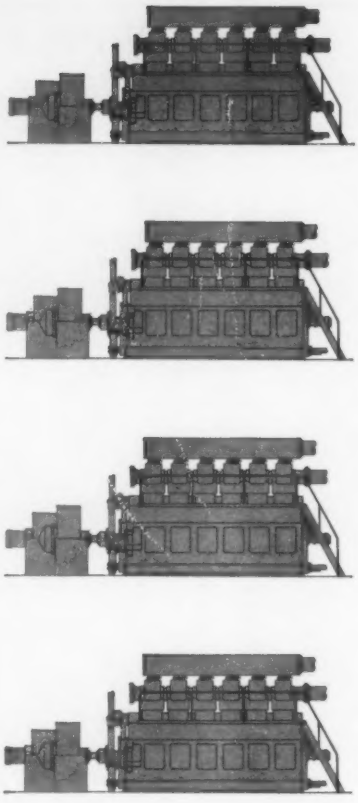
PIPELINES BUILT OR UNDERWAY

COMPANY	Crude	Products	Gas	Miles	Diam. In.	Location	Completion	Cost
South German Gas Supply, Ltd. Stuttgart, Germany	—	—	—	—	—	—	—	—
South Jersey Gas Co. Atlantic City, N. J.	—	—	√	11	8, 10	Woodcrest to Medford Lakes, N. J.	9/61	$580,000
South Saskatchewan Pipe Line Co. Regina, Sask., Canada	√	—	—	22	4, 6	Dollard to Rapdan, Sask.	UC	$300,000
Southern California Gas Co., Southern Counties Gas Co., (subsidiaries of Pacific Lighting Corp.) San Francisco, Calif.	—	—	—	—	—	—	—	—
Southern Natural Gas Co. Birmingham, Ala.	—	—	√	7.3	10	Hub field to Dexter line, Miss.	11/60	
	—	—	√	11	8	Dexter station to end of Sandy Hook line, Miss.	11/60	
	—	—	√	7	8	Cahaba River crossing, Ala. to existing Calera loop, Ala.	12/60	
	—	—	√	3.1	4	Three Bayou Bay field to Lake Enfermer line, La.	5/61	
	—	—	√	1.3	4	S. Little Lake field, La., to Lake Enfermer line	5/61	$827,000
Southern Union Gas Co. Dallas, Tex.	—	—	√	65	2–16	San Juan, Lea, Eddy and Bernalillo counties, N. M.	1960–61	$1,458,000
Standard-Vacuum Oil Co. New York, N. Y.	—	—	—	—	—	—	—	—
St. Lawrence Gas Co. Ogdensburg, N. Y.		—	√	75	—	Cornwall, Ont., to Ogdensburg	UC	—
Sui Gas Transmission Co. Multan, India	—	—	—	—	—	—	—	—
SunOlin Chemical Co. Philadelphia, Pa.	—	√	—	80	4, 6	Deepwater to Paulsboro, N. J.	UC	—
Suwannee Pipeline Co. Atlanta, Ga.	—	—	—	—	—	—	—	—
Syrian Government Damascus, Syria	√	—	—	320	6	Producing fields to Homs refinery	1961	—
Teikoku Oil Co., Ltd. Tokyo, Japan	—	—	—	—	—	—	—	—
Tenn.-Calif. Gas Transmission Co. Houston, Tex.	—	—	—	—	—	—	—	—
Tennessee Gas Pipeline Co. Houston, Tex.	—	—	√	25	30	Near Hamburg, N. Y.	UC	—
	—	—	√	126	4–16	Louisiana and Texas	6/61	—
Teton Pipe Line Corp. Sterling, Colo.	√	—	—	68	3, 4, 6	Dead Horse, Barber Creek and Sussex fields to Service Pipe Line at Sussex, Wyo.	7/61	—
Texaco Exploration Co. Calgary, Alta., Canada	—	—	—	—	—	—	—	—
Texas Eastern Transmission Corp. Houston, Tex.	—	—	√	40	36	Station 26, N. J., to station 27, N. J.	UC	
	—	√	—	7	8	Pasadena to Deer Park, Tex.	UC	
	—	—	√	83	24	Leidy storage field to Perulack station, Pa.	Late '60	
	—	—	√	139	20–3	Loops in Pennsylvania, Texas and Mississippi	Late '60	
	—	√	—	5	12	Chicago main line to Zionsville, Ind.	UC	$250,000
Texas Eastman Co. Longview, Tex.	—	—	—	—	—	—	—	—
Texas Gas Transmission Corp. Owensboro, Ky.	—	—	√	29.5	12	Slaughter to Greenville, Ky.	7/61	
	—	—	√	67	4–16	Gathering systems in Southern Louisiana	5/61	
	—	—	√	5.34	4–16	Field lines in gas storage field	6/61	
	—	√	—	11.68	6	Dual lines	2/61	
	—	—	√	55.5	12	Hymera to Bedford, Ind.	11/60	$9,000,000
Trans-Canada Pipe Lines Ltd. Toronto, Canada	—	—	—	—	—	—	—	—

PIPELINES PROPOSED OR PLANNED

Crude	Products	Gas	Miles	Diam. In.	Location	Cost	HP added last 12 months	HP Planned	Cost
—	—	√	200	—	Mannheim to Ulm via Kiel, Germany		—	—	—
—	—	√	40	—	Kiel to Frieburg	$24,000,000			
—	—	√	16.5	12	Forrest Grove to Pleasantville, N. J.		—	—	—
—	—	√	12.5	10	Mays Landing to Pleasantville, N. J.	$1,200,000			
—	—	—	—	—	—	—	—	—	—
—	—	√	92.9	34	Ivanpah Lake to Newberry, Calif.		10,000	—	$4,573,500
—	—	√	24	16	Gaviota to La Goleta, Calif.	$13,176,000			
—	—	√	1.9	4	Grange field to Franklinton-Gwinville line, Miss.		—	—	—
—	—	√	1.7	8	Bayou Long field to Little Bayou Pigeon gathering line, La.	$115,500			
—	—	√	26	4-20	San Juan, Sandoval and Eddy counties, N. M.		—	—	—
—	—	√	2	6	Reeves County, Tex.	$920,000			
—	—	√	60	8	Radja field to Palembang, Sumatra	—	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	√	145	8	Sylhet to Dacca, East Pakistan		—	—	—
—	—	√	130	16	Multan to Lyallpur	—			
—	—	—	—	—	—	—	—	—	—
—	√	—	800	22	Baton Rouge, La., to Greensboro, N. C.	—	—	—	—
—	√	—	300	—	Homs to Damascus, Aleppo and Latakia	—	—	—	—
—	—	√	215	—	Kubiki to Tokyo	$13,900,000	—	—	—
—	—	√	105	26	King Ranch, Tex., to Reynosa, Mexico		—	—	—
—	—	√	69	12	Laterals in Kleberg, Brooks and Hidalgo counties, Tex.	—			
—	—	√	217	26, 30, 36	Kentucky, Ohio and Pennsylvania		12,000		—
—	—	√	39	12-20	Louisiana	—		74,000	—
—	—	—	—	—	—	—	—	—	—
√	—	—	50	8	Rimbey field to Edmonton, Alta.	—	—	—	—
—	—	√	131	30	Kosciusko station, Miss., to station 21-A, Pa.		3,900	—	$830,000
—	—	√	85	30	Delmont station, Pa., to station 26, N. J.				
—	—	√	165	20	West Monroe, La., to Kosciusko station, Miss.				
—	—	√	57	14	Castor to West Monroe, La.				
—	—	√	13	14	Middlesex county to Barnardsville, N. J.				
—	—	√	14	12	Barnardsville to Roseland, N. J.				
—	—	√	11	10	Middlesex county to Helmetta, N. J.	—			
—	√	—	275	6	Harrison County, Tex., near Longview, to Phillips' salt dome storage facilities at Clemens Dome, via Tyler	—	—	—	—
—	—	√	71	8, 16, 26	South Louisiana		8,460		$2,742,280
—	—	√	61.32	30	Louisiana, Arkansas, Mississippi, Tennessee and Kentucky			4,000	$1,296,000
—	—	√	5.31	26	Kentucky				
—	—	√	8.28	6	Indiana	$13,353,000			
—	—	—	—	—	—	—	50,500	—	$8,600,000





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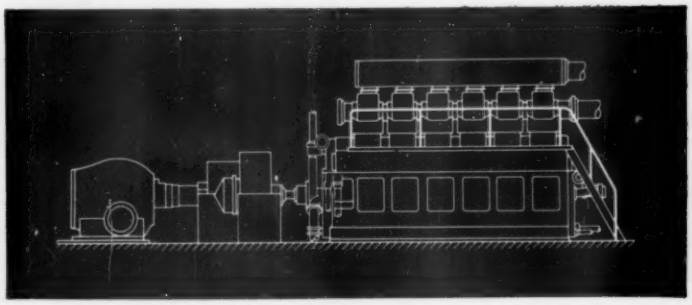

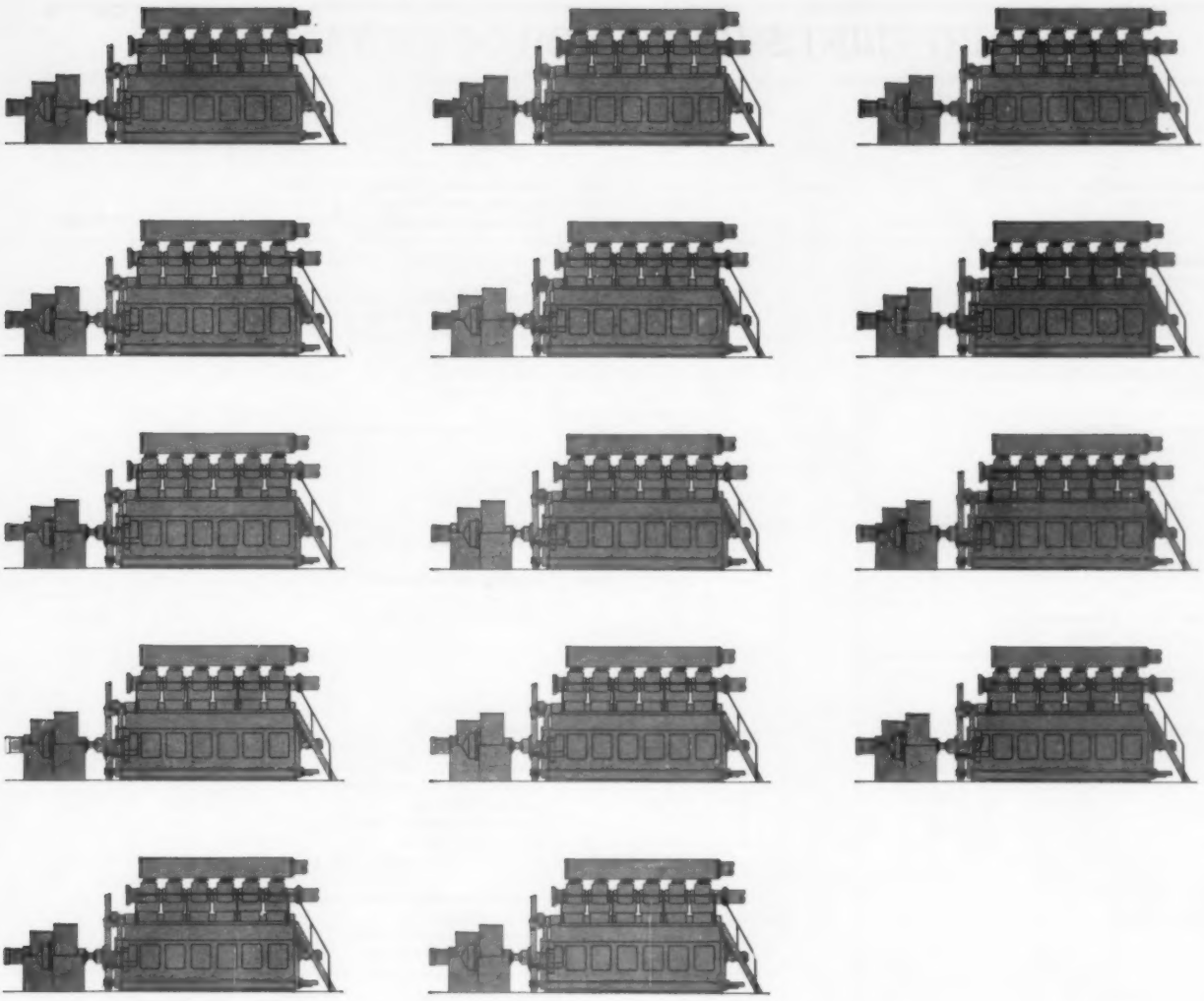

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PIPELINES BUILT OR UNDERWAY

COMPANY	Crude	Products	Gas	Miles	Diam. In.	Location	Completion	Cost
Transcontinental Gas Pipe Line Corp. Houston, Tex.	—	—	√	77	30, 36	Texas, Louisiana, Mississippi and Alabama	1960	
	—	—	√	189	30, 36	Tex., Miss., Alabama, Ga., S. C., N. C.	UC	
	—	—	√	7	12, 16	New Jersey and across Delaware River into Pa.	UC	$40,000,000
Trans-Prairie Pipe Lines Ltd. Edmonton, Alta., Canada	√	—	—	75	4, 6	Taylor, B. C., to Dawson Creek and Boundary Lake	1960	
	√	—	—	75	8	Taylor, B. C. to Milligan Creek, B. C.	3/61	
	√	—	—	9	4	West Beatton, B. C. to Milligan Creek, B. C.	3/61	$5,500,000
Trans-Southern Pipeline Corp. (Transcontinental Gas Pipe Line Corp.) Houston, Tex.	—	—	—	—	—	—	—	—
Transwestern Pipeline Co. Houston, Tex.	—	—	√	100	4, 6	Gathering lines West Texas and Oklahoma	UC	—
Trunk Pipelines Limited London, England	—	—	—	—	—	—	—	—
Trunkline Gas Co. Houston, Tex.	—	—	√	154.5	30	Loops in La., Miss., Ky., Ill.	5-8/61	—
	—	—	√	156.9	16-26	Gathering lines in Louisiana	UC	
Union Gas Co. of Canada Ltd. Chatham, Ont., Canada	—	—	√	19	4, 10	Waterloo to Elmira to Salem, Ont.	7/61	$700,000
United Fuel Gas Co. Charleston, W. Va.	—	—	√	—	—	—	—	—
United Gas Pipe Line Co. Shreveport, La.	—	—	√	7.52	16	Escambia County, Fla.	11/60	
	—	—	√	22.55	20	Comal County to Hays County, Tex.	12/60	
	—	—	√	12.03	8	San Jacinto County to Walker County, Tex.	5/61	
	—	—	√	8.59	30	Angelina County to Jasper County, Tex.	5/61	
	—	—	√	8.20	4	Lafayette Parish, La.	6/61	
	—	—	√	22.37	24	Ft. Bend County to Harris County, Tex.	7/61	
	—	—	√	6.43	6	West Carroll Parish, La.	7/61	
	—	—	√	216	30	St. Mary Parish to Ouachita Parish, La.	UC	$54,812,000
USSR Moscow, Russia	—	—	√	800	40	From Krasnodar fields to Serpukhov	UC	
	—	—	√	310	32	Ringing Moscow	UC	
	√	√	—	2315	28	Ufa and Tuimazy fields to Irkutsk	UC	
	—	√	—	700	—	Novo-Kuibyshev to Bryansk	UC	—
Utah Gas Pipeline Corp. Salt Lake City, Utah	—	—	—	—	—	—	—	—
Valley Pipe Line Dept., Royalite Oil Co., Ltd. Calgary, Alta., Canada	√	—	—	1	4, 6	Part of Turner Valley-Calgary trunk system	8/60	—
Western Slope Gas Co Denver, Colo.	—	—	√	36.5	4-6	Piceance Creek to Powell Park; Rifle to S.U.G. Co. wells; Palisade to Cameo; W. Douglas Creek to Cont'l wells; Powell Park to Meeker	1-7/61	
		—	√	160	3-8	Bondad to Del Norte, Colo.	UC	
	—	—	√	110	2-8	Del Norte to Antonito, Colo.	UC	$6,350,000
West Ohio Gas Co. Lima, Ohio	—	—	√	7.5	4-12	Wapakoneta to St. Marys to Pandora, Ohio; Columbus Grove to Bluffton, and near Lima and Kenton	1961	$126,876
West Shore Pipe Line Co. Des Plaines, Ill.	—	√	—	285	10, 16	Hammond, Ind. to Green Bay, Wis.	UC	—
Western Pacific Products & Crude Oil Pipelines Ltd. Vancouver, B. C., Canada	√	√	—	504	12	Taylor to Kamloops, B. C.	UC	$28,500,000
Wyco Pipe Line Co. Dupont, Colo.	—	√	—	—	—	—	—	—
Yacimientos Petroliferos Fiscales Argentine (YPF) Buenos Aires, Argentina	√	—	—	394	14	Fields in Neuquen Province to Bahia Blanca	UC	$23,000,000
Yacimientos Petroliferos Fiscales Bolivianos (YPFB) La Paz, Bolivia	√	—	—	407	12	Camiri to Sica-Sica	—	—

PIPELINES PROPOSED OR PLANNED

Crude	Products	Gas	Miles	Diam. In.	Location	Cost	HP added last 12 months	HP Planned	Cost
—	—	√	187	36	Louisiana, Mississippi, Alabama, Georgia, South and North Carolina, Virginia, and Maryland		38,000		$11,000,000
—	—	√	153	3, 8, 20	Offshore Louisiana	$28,000,000		26,700	$ 9,500,000
—	—	—	—	—	—	—	1,000	—	$130,000
—	√	—	1080	12	Mont Belvieu, Tex., to Danville, Va.		—	—	—
—	√	—	275	—	Spurs from Atlanta to Georgia-Florida state line; Laurel to Hattiesburg, Miss., and Linden to Demopolis, Ala.	$63,000,000			
—	—	—	—	—	—	—	—	—	—
—	√	—	72	—	Canvey Island to Denham, England	—	—	—	—
—	—	√	123.0	10, 30	Loops in La., Miss., Ky., Ill.	—	26,600	—	—
							—	12,000	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	2,150	—	$531,000
—	—	√	59.15	36	Terrebonne Parish to Bastian Bay field in Plaquemines Parish, La.	—	1,800	—	$561,662
—	—	√	250	—	Ust-Vilyuisk field to Yakutsk and Pokrovsk		—	—	—
—	—	√	2600	40	Two 1300-mile parallel lines from Gazli to Sverdlovski and Chelyabinsk	—			
—	—	√	200	—	San Arroya field to Salt Lake City	$15,000,000	—	—	—
—	—	√	27	4	Wildcat hills and Jumping Pound fields to present U. P. L. system south of Calgary	$500,000	—	—	—
—	—	√	20	2-4	8-in. main line to Frontier well; Piceance Creek to Equity well; Rifle to New Castle; W. Douglas Creek to Cont'l wells, Colo.	$200,000	375	170	$90,000 $40,000
—	—	√	1	8	Delphos to Van Wert, Ohio	$20,800	—	—	—
—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	3,500	11,480	$1,800,000 $3,800,000
—	—	—	—	—	—	—	500	—	$60,000
√	—	—	630	12	Mendoza to San Lorenzo		—	—	—
—	√	—	650	10	Lujan de Cuyo refinery in Mendoza Province to Buenos Aires area				
—	—	√	1000	30	Comodoro Rivadavia in Patagonia to Greater Buenos Aires area	—			
—	—	—	—	—	—	—	—	—	—

by Mario Monti

Oil-Hungry Europe Pushes Pipelining

Europe's surging demand for petroleum energy is the big push behind a rash of present European crude oil pipeline activity. Growth of petrochemicals and use of oil for energy in a low production area are the motivating forces for this pattern.

Imports, rapidly increasing for the past 10 years, are nine times that of average yearly U. S. imports. New refineries are built inland in intensely industrialized areas where demand is greatest. Road, rail and waterway traffic to these areas has gradually approached a saturation point. All of these factors have contributed to the building of more and more pipelines to move crude oil from coastal receiving points to inland refineries.

Europe's petroleum consumption in 1960 was 160,000,000 tons (1 ton = 7.454 bbl 36-gravity crude), while local production barely reached 13,500,000 tons. Consumption forecast for 1965 is no less than 200,000,000 tons (which could rise to 240,000,000 tons if local extraction of coal and lignites declines more than expected), but local production is expected to be only 20,000,000 tons. Estimated consumption for 1975 is projected as between 300,000,000 and 390,000,000 tons, against total production of 30,000,000 tons.

Pipeline Picture Through '60

With the exception of recent installations to supply complete industrial areas, pipelines in Europe are localized installations for refinery purposes.

The only pipeline in Western Europe before the last war was the Austrian line from Zisterdorf on the Danube to the nearby Lobau refinery.

The first to be constructed after the war was the 50-mile English pipeline from Finnart to Grangemouth in Scotland. This permitted tankers in the Atlantic that supplied the refinery located high up the Firth of Forth to shorten their voyage by about 400 nautical miles.

All other pipelines listed in Table 1 were built for similar reasons until 1959-1960 when the large diameter pipelines from Wilhelmshaven and Rotterdam to the Rhineland were put into operation.

Effect of Saharan Finds

The first pipeline intended for the general supply of West European markets is the one proposed to carry oil from the Sahara into the hinterland from Lavera (Marseilles).

First oil discoveries in the Algerian Sahara were in 1955. Intensive operations to ascertain

Table 1. Crude Pipelines Operating, Under Construction, or Projected O.E.E.C. Area To End of 1960.

Routes	Length, miles	Capacity (million tons per year) initial	final	Diam. In.	Completion date
Zisterdorf-Lobau	30.5	(less than 2)		12	before 1939
Finnart-Grangemouth	56.5	—	3.1	12	1951
Vado Ligure-Trecate (Novara)	94.5	1.0	—	8	1952
Genoa-Rho (Milan)	80	1.1	—	12	1953
Parentis-Bec d'Ambes	74.5	1.5	3.0	16-12	1958
Le Havre-Petit-Couronne	49	2.3	3.0	10	1959
Wilhemshaven-Cologne	242	9.0	22.0	28	1959
Wesel-Gelsenkirchen	29	—	6.0	18	1959
Rotterdam-Cologne	177	8.5	20.0	24	1960
Milford Haven-Llandarcy	60	—	6.0	18	1960
Genoa-Aigle-Ulm-Ingolstadt	621	—	18.0	26-12	1963
Lavera-Strasburg-Karlsruhe-Ingolstadt	683.5	10.0	30.0	32-28	1963

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the nature and size of the deposits followed, and, in 1957, the French and other groups engaged in the area were convinced that volume of production found in the two zones in the Sahara not only justified construction of pipelines but required them for full exploitation.

It was decided to construct a pipeline from the locality of Edjeleh-Zarzaitine-etc. to the port of La Skirra (Gulf of Gabes) and another from the locality of Hassi Messaoud—El Agreb to the port of Bougie on the Mediterranean coast. A separate pipeline linked the latter to production at Ohanet, discovered later.

The pipelines were constructed in record time. Specifications were: diameters, 24 in.; length, for Bougie, 660 km (410 miles); for La Skirra, 780 km (485 miles); maximum capacity, with four pumping stations per line, 14,000,000 tons per year.

In France, at the same time, those companies engaged in production of African oil, as well as those engaged in refining and distribution of products, enlarged and formed as a company the survey group that had been formed in 1956 (the SAPPEUR). This company, called SOPIMER, was to lay a pipeline for transporting Sahara oil from the Mediterranean to Central and Northern Europe, that is, beyond France. Thus was born in 1958 Société du pipeline du Sud Européen (SPSE) which absorbed SOPIMER and took over the task of laying the pipeline planned by the latter, working in conjunction with French, German, Anglo-Dutch and American groups (16 distinct groups collaborating).

The pipeline will be capable of transferring 10,000,000 tons per year from Lavera to Strasbourg by the end of 1961 and 30,000,000 tons per year by the end of 1962, when 10,000,000 tons per year will be consigned to Karlsruhe. Two German companies that are a part of SPSE will extend the pipeline from Strasbourg to Karlsruhe and thence to Ingolstadt.

Capacity of the Lavera-Strasbourg-etc. pipeline corresponds to the overall capacity of the two African pipelines. Terminals of the latter, at Bougie and La Skirra, are already working in conjunction with the European pipeline from Lavera. Since 1960 tankers have been unloading their oil at Lavera.

What Libyan Finds Offer

Libyan finds, made shortly after those in the Algerian Sahara, offer prospects even more encouraging in view of their distance from the Mediterranean coast and their nature.

Finds in Algeria can be estimated now at 500,000 tons of oil and one billion cu m of natural gas. Estimates for the finds in Libya differ, but it already is believed there are twice the reserves of hydrocarbons there as in the Algerian Sahara.

Even more interesting is the Libyan deposits' proximity to the coast. Those found by Esso Standard of Libya are less than 100 miles from the Mediterranean coast at 400 m (1312 ft) above sea level and can thus reach the coast under the force of gravity.

About 100 km (62 miles) to the west, Oasis Oil of Libya (an association of American companies for Libya: Continental Oil, Amerada Petroleum Corp., and Ohio Oil International) has in part marked out economically workable deposits at only 140 km (111 miles) from the coast.

These two areas, Zelten and Bahi-Dahra, are now ready for production on an industrial scale and are only awaiting completion of pipelines that were begun in 1959 in the case of Esso and in 1960 in the case of Oasis. The 30 in. diam. lines reach the sea from Zelten at Marsa El Brega and 200 km (125 miles) farther west at Es Sider. The Oasis pipeline will be completed shortly, as the Esso line is now.

Chief difficulty in organizing mass export from Libya is the need to construct sound ports in an area unsuitable for such undertakings. For many months of the year, a wind from the desert (the "ghibli") interrupts maritime operations violently and persistently. Nevertheless, Libya is now considered a producing country exporting oil at a level not inferior to that of Algeria.

Difficulties are being overcome, and exportation from Libya is exported to begin in 1961.

Europe sees in Libya the best possibility for direct transfer of oil by sea-bed pipelines. The laying of these lines seems practicable because of shallow waters between the entire length of the south coast of Sicily and the African coast from Cape Bon in Tunisia to Misurata to the east of Tripoli.

An agreement was signed with a private company last July to determine the feasibility of the project. Whether it travels along the ocean bed from Misurata to Malta and on to Cape Passero or along the more distant but shorter and shallower sub-ocean path [(100-300 m (328-984 ft) instead of 500-600 m (1640-1968 ft)] from Cape Bon in Tunisia to Mazara del Vallo in Sicily, oil reaching Europe would run the whole length of Italy, cross the Alps by Brenner Pass, penetrate to the heart of Central Europe, and then be directed wherever needed.

Soviet oil enterprise has been noted, particu-

larly movement toward European markets based on the potentiality of a huge pipeline (diameter, 40 in; length, 5500 km (3400 miles) including principal laterals; capacity, 50,000,000 tons per year) that extends from the region of the Middle Volga-Urals at the extreme eastern point of geographical Europe.

The feature of the Soviet pipeline is the continuity of the system from producing wells to consuming area without other intervening methods of transportation. This eliminates technical complications and heavy costs. In contrast, the French Sud-European pipeline begins with two lines that transport oil to coastal points that must be equipped with facilities for receiving, loading and helping ships of large tonnage. Added to that are hundreds of miles of navigation and then disembarkment on another coast, followed by the introduction of the oil into a third pipeline.

Continuous transport by pipeline from producing wells to points of consumption has given rise to the term "sorgivo" to indicate "carriage from the source to the employment" without interrupting the continuity of the method of transfer.

The Soviet pipeline from Kuybiscev to Europe, then, is "sorgivo," just as the pipeline from Libya to Central Europe, once it has been laid and functions, will be "sorgivo." The French Sud-European pipeline may well become sorgivo, once French efforts to lay pipes across the bed of the Mediterranean meet with success and dispense with tanker fleets and specialized ports on the coasts that now shift the oil from the Sahara to metropolitan France and Europe. But the pipeline that Ing. Enrico Mattei (head of ENI) recently inaugurated for the second time can never be "sorgivo" because it would not be linked to a source of production. At Multedo (Genoa) where the pipeline begins, oil must be imported to the amount of 18,000,000 tons per year.

In the face of invasion of European oil markets by Russian oil from the Middle Volga-Urals region, our efficacy can lie only in undertakings on a similar scale with oil in quantities and at costs that are absolutely competitive. Under different conditions, any competition whatsoever cannot be efficacious.

Other "Sorgivo" Lines?

As indicated, Western Europe must import at least 200,000,000 tons in 1965 and at least 300,000,000 tons in 1975.

It does not seem likely that the Sahara and Libya alone, however favorably present research progresses, will be able to supply Europe with oil in sufficient volume. This is why the possibility of establishing continuous supplies of a "sorgivo" kind, with uninterrupted continuity by pipeline from the Middle East to Europe, has been considered.

A visional perspective of the "GOTA" pipeline from Libya to Central Europe.

If Mediterranean oil from Libya and the Sahara can reach the continent of Europe by ocean-bed pipelines, Middle East crude can follow the same route. Oil that today emerges on the Persian Gulf can be switched directly to Europe through Libya. Pipelines 3000 km (1865 miles) long would be needed. These are no longer than the lines with which Russia is attempting to take the lead in the markets of western Europe.

Difficulties that a plan of this kind would meet are not so technical as they are political, especially among the Arab states. On the other hand, there is no doubt that a scheme on such a large scale would be received with great interest, not only in the economic world, but particularly in the strategic spheres of the defense of the free Western world.

Mario Monti, INM, naval architect and doctor in mechanical engineering.

■

Coming Construction

$49,000,000 Proposal Filed

Transcontinental Gas Pipe Line Corp. has filed an application with the Federal Power Commission for permission to build new facilities totaling $49,000,000.

Largest part of the proposed construction would be 188 miles of 36-in. main line paralleling Transco's existing system in Louisiana, Mississippi, Alabama, Georgia, the Carolinas, Virginia, Maryland and Pennsylvania.

An additional 46,800 hp would be added at 13 Transco compressor stations in seven states. Other construction detailed in the application includes: 28 miles of 20 and 24-in. gathering laterals in Louisiana; additional horsepower at the station near Eunice, La.; a new intermediate compressor station on the McMullen gathering system in Goliad County, Tex.; and metering and regulating facilities in Bucks County, Pa.

The new facilities would permit an increase of 93,405,000 cu ft per day to 32 existing resale customers in nine states.

Four UGPL Filings Accepted

Four United Gas Pipe Line Co. applications, the earliest dating back to Nov. 4, 1960, have been accepted for filing by the Federal Power Commission.

The applications are: CP 61-131, proposing 40 miles of 24-in. loop on the Mobile, Ala.-Pensacola, Fla., line at a cost of $3,871,432; CP 61-331, seeking permission for 10.2 miles of 30-in. loop in Terrebonne and Assumption parishes, La., at a cost of $1,959,917; and two "budget" applications for 1962.

$15,000,000 Program to Start

Panhandle Eastern Pipe Line Co. announces it will proceed immediately with a $15,000,000 construction program that will complete Trunkline Gas Co.'s second largest diameter main transmission line from Longville, La., to Tuscola, Ill.

Panhandle and its subsidiary, Trunkline, have accepted a revised allocation plan issued by the Federal Power Commission but reiterate opposition to a portion of the allocation to Michigan Consolidated Gas Co. The FPC orders 8,000,000 cu ft per day of the new capacity to Michigan Consolidated pending final action on requests of 14 Illinois and Missouri communities for that volume.

The new facilities will increase deliveries to 29 utilities in five Midwest states.

Feeder to Dixie Line Planned

Service Pipe Line Co. is planning construction of a 21-mile, 4-in. natural gas liquid line connection between the Hudson Gas and Oil plant in Port Acres, Tex., and the Dixie Pipeline system in Orange County, Tex.

Service also plans to build a pumping station on the 21-mile system which it will own and operate. Dixie will provide metering facilities at the tie-in point.

H. G. Mariner, Service general manager, said that C. A. Kohler of Beaumont, Tex., has been awarded the contract for survey of the feeder system, which when completed is expected to move between 2000 and 4500 bpd of propane from the Hudson plant to Dixie.

Worsley, Alta., Line Planned

Trans-Prairie Pipe Lines Ltd. seeks permission to lay a 43-mile, 6-in. crude oil pipeline from a discovery well at Worsley in Northwestern Alberta to a point on the British Columbia boundary near B.C.'s Boundary Lake field.

The proposed line would pick up oil from two other isolated discovery wells in the Worsley area and would make delivery to the gathering system which Trans-Prairie operates in Boundary Lake. This system terminates at Taylor pumping station and provides access to the new pipeline leading to Kamloops, making a direct connection to the Vancouver refineries.

PG&E Starts Gathering Lines

Pacific Gas and Electric Co. has embarked upon a $2,300,000 project to install 44 miles of 3 to 20-in. diam pipelines to gather natural gas from the Grimes, Buckeye and Kirk areas of Sutter and Colusa counties, Calif.

The gathering system's main line will originate in Sutter County northeast of Grimes, run southwest, cross the Sacramento River at Grimes, then connect to PG&E's existing 20-in. Westside line near Dunnigan. A dozen laterals of varying lengths and diameters will join wells to the system along the route.

The system will have enough capacity to connect all present wells and additional wells which may be developed.

Shell to Lay East Texas Line

Shell Pipe Line Corp. this month expects to get underway the construction of a 34-mile, 8-in., 6600-bpd condensate and gas liquids pipeline from the Bryans Mill Smackover field area in north Cass County, East Texas.

The feeder line will extend southwest from Bryans Mill to Pittsburg in Camp County to connect with an Humble Pipe Line Co. system moving south to Kilgore in the East Texas field. Shell will pick up the condensate at the latter point and move it through its main East Texas-Gulf Coast trunk line to its Houston refinery.

Additional fluids will be moved upon completion of a gas processing and sulfur recovery plant being built by Bryans Mill field producers with Shell as operator.

Shell expects to complete the feeder by the end of the year.

Ohio Replacements Okayed

Ohio Fuel Gas Co. has Federal Power Commission permission to replace existing lines with larger diameter pipe to provide an increase in system capacity.

The firm will replace 5.7 miles of 12-in. with 20-in. at a cost of $375,000, 8.4 miles of 8-in. with 12-in.

Special Properties of Spiral Welded Pipes:

The welding seam acts as a bandage, and thus supports the pipe, so that a higher rigidity is given to it.

The welding seam and the grain of the rolled sheet run diagonally to the direction of the main stress, so that a higher safety of the pipe is guaranteed.

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wall thickness
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lengths up to 49'
according to all standards in question and in any desired quality.

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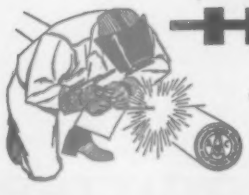
One of the Hardest Jobs on the "HARD YARD*" Is Being HANDLED BY HOOD

The final link of the 1,017-mile *Alberta California Pipeline is being constructed by Hood Corporation, California based pipeline contractors. This is one of the hardest jobs of the entire project, which has been so difficult that it is called the "Hard Yard."

Hood's work consists of completing the southernmost section, under contract to Pacific Gas and Electric Company, and includes:

Two 26" pipelines across the Sacramento River—the peat bogs of Sherman Island—the San Joaquin River—and a 36" line to Antioch Terminal—a total of 26,500 feet, dual lines almost all the way.

Hood is proud to have a part in the completion of this important job and offers congratulations to the management and engineers of the firms who conceived and developed the project . . . Pacific Gas and Electric Company, Pacific Gas Transmission Corporation, Bechtel Corporation and all the Canadian firms.



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at a cost of $375,000, and 4.5 miles of 8-in. with 12-in. at a cost of $196,000. These facilities will increase peak-day capacity for retail service in Lorain, Cuyahoga, Stark, Carroll, Perry and Muskingum counties, Ohio.

Estimated cost of retirement of the existing lines is placed at $48,000. Estimated salvage is $60,000, with credit to fixed capital estimated at $150,000.

FPC Filings

Arkansas Louisiana Gas Co., Shreveport, La., CP 62-73, filed Sept. 21, 1961. *Construction*: during 1962, taps and connections as needed for customers in areas adjacent to the applicant's transmission system.

Cost: not more than $750,000 total, with single projects limited to $200,000.

Atlantic Seaboard Corp., Charleston, W. Va., CP 62-67, filed Sept. 15, 1961. *Construction*: measuring and regulating facilities for sale of gas to Navgas Inc. for service to a Naval Radio Research station near Sugar Grove, Pendleton County, W. Va. (Navgas to request authority to construct 24.2-mile, 6⅝-in. transmission line from interconnection to Naval Radio Research station.)

Cost: $19,600 which includes: meter runs, $440; gages, $820; regulators, $1450; controllers, $1170; indirect heater, $1000; pipe, valves and fittings, $4520; land, $500; building, $1000; labor and miscellaneous expense, $7150; interest and overhead, $1550. Annual operating expense totaling $670 includes $280 for operation labor, $320 for operation material and expense, $40 for maintenance labor and $30 for maintenance material and expense.

Columbia Gulf Transmission Co., Houston, Tex., and Kentucky Gas Transmission Corp., Charleston, W. Va., CP 62-56, filed Aug. 31, 1961. *Construction*: 6-in. main line tap and sidegate by Columbia, as well as main line tap and sidegate, pressure regulator and 4-in. orifice type measuring station by Kentucky—an emergency connection between the two systems in Madison County, Ky.

Cost: for Columbia, $4400 which includes: main line tap and sidegate, $2900; engineering, inspection, $200; equipment, hauling, $700; miscellaneous, $200; overhead, $400. For Kentucky, $23,900 which includes: measuring station, $7500; regulating station, $5700; valve setting, $6700; engineering,

inspection, $1200; equipment, etc., $600; miscellaneous, $1000; overhead, $1200.

El Paso Natural Gas Co., El Paso, Tex., CP 62-62, filed Sept. 14, 1961. *Construction and costs*: 4½ to 20-in. field laterals not to exceed $500,000 each nor to exceed a total of $1,500,000; compressor equipment ranging from 300 to 1600 hp, not exceeding $500,000 each nor a total of $1,500,000; purification and/or dehydration equipment not to exceed $500,000 each nor a total cost of $1,000,000; and gasoline extraction plant equipment (primarily additions or alterations to existing plants) not to exceed $500,000 each nor a total of $1,000,000.

CP 62-64, filed Sept. 14, 1961. *Construction and costs*: 30 main line taps not to exceed $400 each nor a total of $12,000; 25 main line measuring and regulating and/or check metering stations with main line tap facilities as necessary on transmission lines of applicant or adjacent to facilities of Pacific Gas Transmission Co., $2000 to $7000 each, total $175,000; three 2½ to 6⅝-in. laterals with necessary main line taps, measuring and regulating and/or check metering stations and standard equipment, $350,000 each, not exceeding a total of $1,050,000; main line or field taps at 15 locations at an estimated cost of $400 each, total $6000; portable measuring and regulating facilities at 15 locations at an estimated cost of $1200 each, total $18,000.

Houston Texas Gas and Oil Corp., St. Petersburg, Fla., CP 62-74, filed Sept. 22, 1961. *Construction*: 6.1-mile, 4½-in. OD lateral from applicant's 8-in. serving Florida Power Co.'s Bartlow plant, Panellas County, Fla., near St. Petersburg, east along the western causeway approach to Gandy Bridge, then under Old Tampa Bay to a point off the eastern shore where the line will branch to the National Gypsum Co. plant (where a meter and regulator station will be built) and to the plant of Tiffany (where another meter and regulator station will be built).

Cost: $300,000 which includes $243,700 for pipeline materials and labor; $21,000 for meter and regulator stations; and $35,300 in undistributed costs.

Pacific Gas Transmission Co., San Francisco, Calif., CP 62-59, filed Sept. 11, 1961. *Construction*: taps and metering facilities at Klamath Falls and Bend, Ore., to deliver gas transported for El Paso Natural Gas Co.

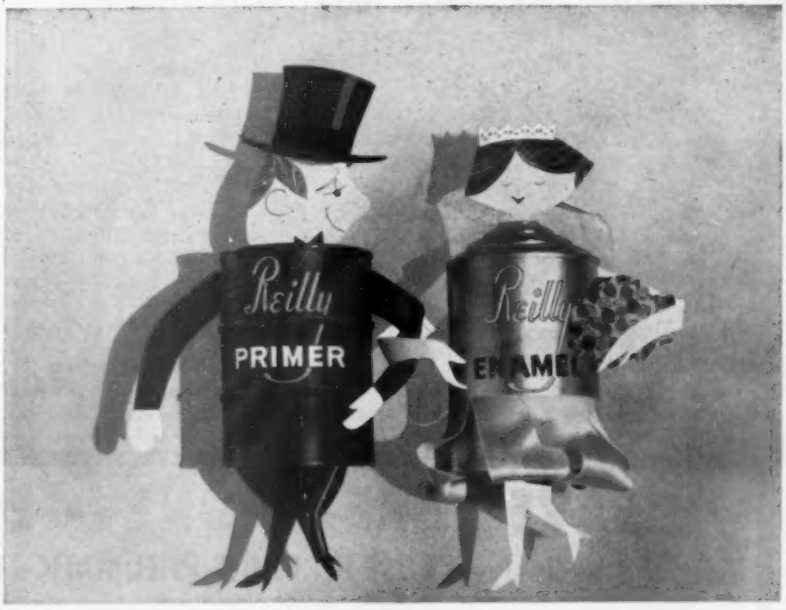
Cost: $26,500 total which includes: insulated buildings, $1350; skid foundations, $900; gas fired heaters, $5750; plug valves, $1880; orifice meter runs, $1030; flow recorders, $1000; temperature recorders, $700; yard pipe and taps, $1000; pipe and fittings, $1450; labor, $7275; pressure regulators, $1125; pressure relief valve, $790.

Lone Star Gas Co., Dallas, Tex., CP 62-72, filed Sept. 21, 1961. *Construction*: various laterals and related facilities in 1962 and later.

Cost: $1,000,000 during 1962, with no project exceeding $250,000.

Lake Shore Pipe Line Co., Cleveland, Ohio, CP 62-75, filed Sept. 22, 1961. *Construction*: 2700 ft of 4½-in. OD between Monroe, Ohio, and Conneaut, Pa., and 1450 ft of 3½-in. OD in two segments to connect two producing gas wells in Conneaut, plus a meter station.

Cost: $18,155 which includes materials and labor for 4-in., 0.188 wt grade B pipe, $9315; 3-in., 0.188 wt grade B pipe, $3915; gage sets, $500; two 2-in. orifice runs, $600; two steel meter houses, $800; border station, $1500; steel meter house for border station, $700; right-of-way and damages, $825.



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Reilly 230 AWWA Enamel	Reilly 230 X-10 Primer	
Reilly Hot Service Enamel	Reilly 230 X-10 Primer	

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Pipeline Contractors

Arthur Brothers Inc., Box 792, Kingsville, Tex. *Tennessee Gas Pipeline Co.* — 5500-hp compressor station at Hamilton, Ala., and 6800-hp addition at Portland, Tenn., station.

Banister Construction Co. Ltd., Box 2408, Edmonton, Alta., Canada. *The Alberta Gas Trunk Line Co. Ltd.*—0.5-mile, 4-in. Chigwell East lateral, 9-mile, 6-in. Wayne-Dalum lateral, 25-mile, 8-in. Kessler lateral and five 4-in. meter runs and buildings. Superintendent of the lateral work is Basil Seemann, and field office is located at Consort, Alta. Joe Burke is superintendent of the station construction.

Bechtel Corp., 220 Bush St., San Francisco 4, Calif. *Texas Eastern Transmission Corp.*—23 miles of 10-in. from New Brunswick to Freehold, N.J. Superintendent: Joe Work.

O. R. Burden Construction Corp., Box 5216, Tulsa, Okla. *Dixie Pipe Line Co.*—Griffin, Ga., to McBee, S.C., portion of 1100-mile, 6, 8, 10 and 12-in. LPG line.

Texas Eastman Co.—207 miles of 275-mile, 6-in. from Longview, Tex. to salt dome storage facilities of Phillips Petroleum Co. at Clemens Dome near Sweeny, Brazoria County, Tex.

R. L. Coolsaet Construction Co., Box 4087, Dearborn, Mich. *Buckeye Pipe Line Co.*—42 miles of 8-in.

A. J. Curtis & Co., Denver, Colo. *Western Slope Gas Co.*—75 miles of 8-in. and 130 miles of 2 through 8-in.

R. H. Fulton & Co., Box 1526 Lubbock, Tex. *Continental Pipe Line Co.*—550 miles of 2, 3, 4, 6 and 8-in. in Montana (field office in Cut Bank) and Wyoming. Red Mitcham is superintendent.

Northern Natural Gas Co. — 15 miles of 30-in. loop out of Laverne, Okla., with Tobe Veach as superintendent; 82 miles of 20-in. from Illinois-Wisconsin line to Janesville, Wis., with Clint Schell as superintendent and Monroe, Wis., as field office; and 26 miles of 26-in. loop out of Manchester, Iowa, with Jack Riffe supervising.

Natural Gas Pipeline Co. of Amer-

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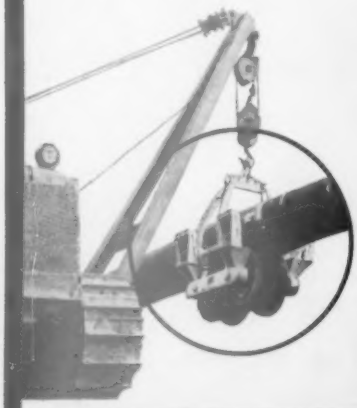

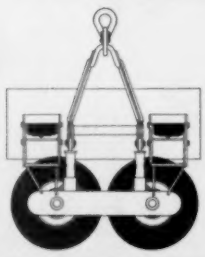

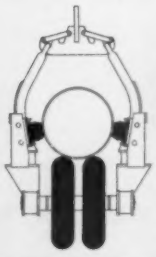

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ica—62 miles of 30-in. loops out of Carlisle and Bellflower, Ill., where field office is located, with Billy Schell supervising; and 42 miles of 36-in. loop out of Bucklin, Kan.

Groninger & King Inc., Box 1381, Pampa, Tex. *Kansas Nebraska Natural Gas Co.*—25 miles of 4, 6 and 8-in. gathering lines near Larned, Kan., where field office is located. Superintendent is L. M. McCathern.

Hall Construction Co., 1105 N. Carlton, Liberal, Kan. *Panhandle Eastern Pipe Line Co.*—a 330-mile, 4 through 12-in. gathering system in western Kansas. Supervising are Mike Bell and M. E. Banning.

Harford Bros., Box 191, Emporium, Pa. *Atlantic Seaboard Corp.*—5 miles of 20-in.

Houston Contracting Co., 2807 Buffalo Speedway, Houston 6, Tex. *Texas Eastern Transmission Corp.* — 161 miles of 20-in. from West Monroe, La., to Kosciusko, Miss.

Dixie Pipe Line Co.—226 miles of 10-in. LPG from Mont Belvieu, Tex., to Baton Rouge, La.

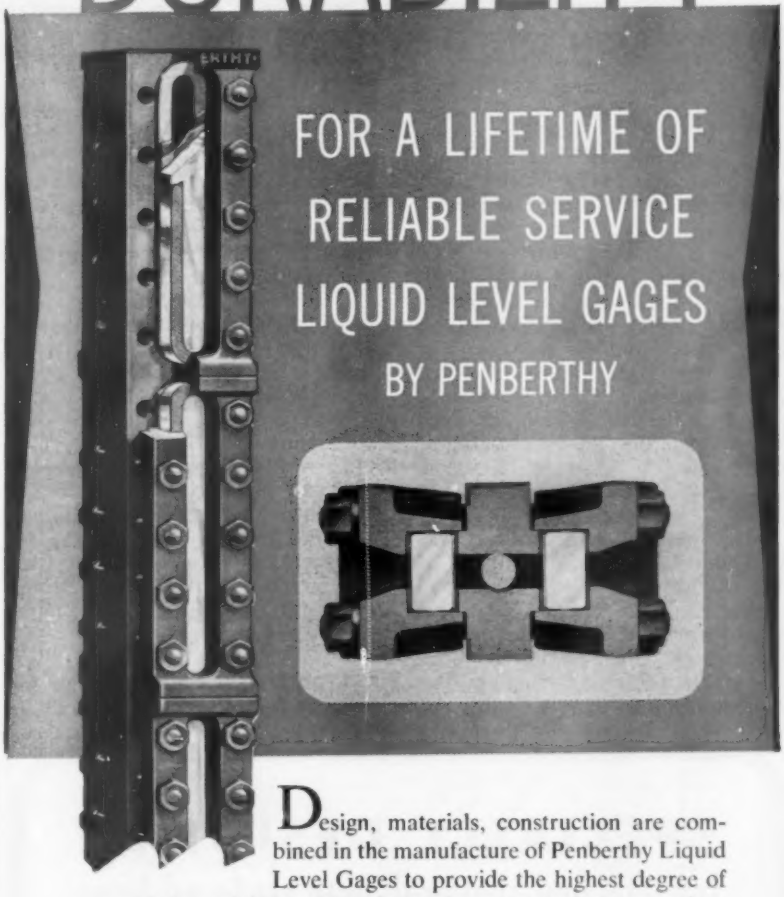
Texas Gas Transmission Corp. — approximately 70 miles of 26 and 30-in. loops from vicinity of Memphis, Tenn., to vicinity of Lafayette, La. Superintendent: A. J. Slovack. Assistant superintendent: L. L. Patterson. Office manager: B. C. Sweeney. Also, 52 miles of 8, 16 and 20-in. from near Bay Round in the Louisiana marsh to near Morgan City, La. Superintendent is R. E. Thornton, and field office manager is S. B. Harrison.

Tennessee Gas Pipeline Co. — 6000-hp compressor station at Purvis, Miss., and 8000-hp station at Port Sulphur, La.

Latex Construction Co. of Ga., Box 11668, Atlanta 5, Ga. *Transcontinental Gas Pipe Line Corp.*—37.1 miles of 36-in. in Georgia and South Carolina: loop 1 starting near Monroe, Ga., and going northeast for 15.4 miles; and loop 2 starting at Anderson, S.C., and going northeast for 21.9 miles. Headquarters: loop 1, Monroe, Ga; loop 2, Belton, S.C. Superintendent: E. L. Myrick.

C. S. LeNoir Construction Co., Box 798, Austin, Tex. *Transcontinental Gas Pipe Line Corp.* — 83 miles of 36-in. in four loops: 21 miles in Walthall, Marion and Jefferson Davis counties, Miss.; 12 miles in Choctaw County, Ala.; 32 miles in Perry and Dallas counties,

DURABILITY



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Ala.; 18 miles in Autauga and Chilton counties, Ala. Superintendent: W. B. Williams. Field office manager: R. E. McManus.

Majestic Contractors Ltd., 49 Jackes Ave., Toronto 7, Ont., Canada. *Gas Trunk Line of British Columbia Ltd.*—29 miles of 16-in. 15 miles of 12-in. 2½ miles of 6-in. and 1 mile of 4-in. in Blueberry, B.C., area. Field offices: Fort St. John, B.C., and Mile 114½ Alaska Hwy. Superintendent: George Oswald.

Mannix Co. Ltd., 737 — 8 Ave. S.W., Calgary, Alta., Canada. *Shell Oil Co.*—13 miles of 8-in. from Sarcee to Jumping Pound, with Odis Hare supervising.

Mid-Mountain Contractors Inc., Box 463, Bellevue, Wash. *El Paso Natural Gas Co.*—26-in. crossing of the Nooksack River in Whatcom County, Wash.

Midwestern Contractors Inc., 130 W. Liberty Dr., Wheaton, Ill. *West Shore Pipe Line Co.* — Hammond station in Lake County, Ill., Blue Island station and junction in Cook County, Ill., Bell station in Cook County, and Romeo station and Des Plaines terminal in Will County, Ill.

J. P. Neill & Co., 522 Meadows Bldg., Dallas, Tex. *Transcontinental Gas Pipe Line Corp.*—from 5 miles northeast of Rockville, Md., to 4 miles northwest of Baltimore. Superintendent: Jack Hays.

O. L. Olsen Co. Inc., 416 Pierce St., Houston, Tex. *Tennessee Gas Pipeline Co.* — 5500-hp compressor station in DeKalb, Miss.

Panama, Inc., 1801 Tennessee Bldg., Houston 2, Tex. *Trunkline Gas Co.*—41 miles of 26-in. and 9 miles of 30-in. between Jennings and Longville, La.

United Gas Pipe Line Co. — 60 miles of 36-in. offshore Louisiana, 60 miles of 30-in. out of Breaux Bridge, La., and 60 miles of 30-in. out of West Monroe, La.

Panama - Williams Corp., 1418 Melrose Bldg., Houston 2, Tex. *Natural Gas Pipeline Co. of America*—73 miles of 30-in. between Hungerford and Refugio, Tex., and 63 miles of 30-in. between Marshall and Spring, Tex., with W. H. Shiflett supervising the former and Emmet Sutton the latter.

Pentzien, Inc., 1504 Dodge St., Omaha, Neb. *Dixie Pipe Line Co.* — single 12-in crossing of Mississippi River near Baton Rouge, La. Superintendent: James R. Zeman.

Piggott Construction Ltd., 608 Renfrew Rideau Towers, Calgary, Alta., Canada. *Alberta Gas Trunk Line Co. Ltd.*—43-mile, 20-in. connecting Kaybob gas field to the main line. Superintendent: Bill Bolt. Office manager: Art Kober.

Pioneer Pipeline Contractors Ltd., Calgary, Alta., and Fort St. John, B.C. *British Columbia Oil Transmission Co. Ltd.*—66 miles of 8-in. main line and 11 miles of 4-in. gathering line to connect Blueberry field with Taylor, B.C.

Poling and Bacon Construction Co. Inc., 10400 South Avenue Extended, Youngstown 14, Ohio. *West Shore Pipe Line Co.* — Jones Island terminal in Milwaukee, Wis., and St. Martins Junction also in Milwaukee County.

H. C. Price Co., Price Tower, Bartlesville, Okla. *Pacific Gas & Electric Co.*—approximately 40 more miles to be completed on the 291-mile, 36-in. California section of the Alberta-California line. Superintendent: Lee Smith. Office manager: George Harvey, at Winters, Calif.

River Construction Corp., Box 9127, Fort Worth 7, Tex. *Transcontinental Gas Pipe Line Corp.*—Goss, Miss., to Seminary; Carmichael, Miss., to W. Butler, Ala.; Verbena, Ala., to Rock Ford; and Franklin, Ga., to Madras. Headquarters: Prentiss, Miss., and Newnan, Ga. Superintendents: T. M. Tatom and H. H. Mehail.

S.A.I.P.E.M., Casella Postale 4159, Milan, Italy. *Oil India Private, Ltd.*—720 miles of 14, 16 and 18-in. from Nahorkatiya to Barauni.

Baghdad, Iraq, Ministry of Industry — 56 miles of 10, 14 and 18-in. from Rumaila to Basrah.

SNAM (Oleodotti Internazionali) —118 miles of 24 and 26-in. from Genoa to Ponte Tresa; 120 miles of 16 and 18-in. from Ferrera to S. Bernardo; 53 miles of 22 and 24-in. from Ponte Tresa to S. Bernardino; 90 miles of 22-in. from S. Bernardino to St. Margrethen; and 37 miles of 16-in. from S. Bernardo to Aigle. Also for SNAM, 59 miles of 18 and 20-in. from Cremona to Bologna.

Y.P.F. (Buenos Aires, Argentina) — 106 miles of 6, 8 and 10-in. in the Comodoro oil field.

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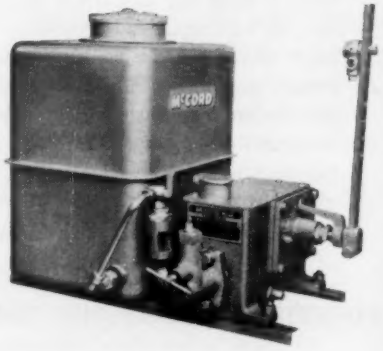

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Sadler Bros. Pipeline Construction Co., 617 Cravens Bldg., Oklahoma City, Okla. *Mustang Fuel Corp.*—30 miles of 4 through 10-in. in Oklahoma.

Shamrock Constructors Inc., Box 505, Dodge City, Kan. *Arkansas Louisiana Gas Co.* — 23 miles of 12-in.

Sharman, Allen, Gay & Taylor, Inc., Box 13152, Houston, Tex. *Dixie Pipe Line Co.* — from the Mississippi River to Demopolis, Ala. — a portion of the 1100-mile, 6, 8, 10 and 12-in. LPG line.

Sheehan Pipe Line Construction Co., 514 National Bank of Tulsa Bldg., Tulsa, Okla. *Transwestern Pipeline Co.* — has underway an additional 100 miles on the 4, 6 and 8-in. gathering system in Oklahoma and Texas. J. W. Brown is superintendent.

SunOlin Chemical Co. — 50 miles of 6-in. and 30 miles of 4-in. in New Jersey from Paulsboro to Deepwater. C. M. Brown is superintendent.

Somerville Construction Co., 6648 Fulton Rd. East, Ada, Mich. *Michigan Wisconsin Pipe Line Co.* — 26 miles of 30-in. in Ottawa, Allegan and Berrien counties, Mich. Headquarters: Ada. Superintendent: Harold Cook.

Stanley-Bledsoe Corp., 612 Daniel Bldg., Tulsa 3, Okla. *Dixie Pipe Line Co.* — 30 miles of 8-in. and 96 miles of 6-in. from north of McBee, Chesterfield County, S.C., to south of Apex, Wake County, N. C. Headquarters: Cherau, S.C., and Sanford, N.C.

Taylor Woodrow Services Ltd., 345 Ruislip Rd, Southall, Middlesex, England. *Scottish Gas Board*—approximately 2 miles of 12-in. across Tay Railway bridge, Dundee, Scotland. J. Reeves is in charge. J. W. Ashton is contracts manager. G. Carr is project manager.

Tulsa Williams Co., 326 National Bank of Tulsa Bldg., Tulsa 3, Okla. *Texas Eastern Transmission Corp.* — 40 miles of 30-in. (four loops) across Pennsylvania. M. O. Thompson is superintendent. Headquarters: Mt. Union.

Vaughn & Taylor Construction Co., Inc., Box 3266, Odessa, Tex. *Western Slope Gas Co.* — 110 miles of 2 through 8-in., with laterals, from Del Norte, Colo., to Antonio, with D. D. Vaughn as general superintendent. Field office: Alamosa.

Williams Bros. Co., National Bank of Tulsa Bldg., Tulsa, Okla. *Natural Gas Pipeline Co. of America* — two 30-in. loops totaling 78 miles in Arkansas — near Arkadelphia and Corning. T. E. Davis is superintendent. Field office: Pocahontas.

American Telephone & Telegraph Co. — 185 miles of cable between Rushville, Ohio, and Williamstown, Ky., under the supervision of J. S. Martindale at Lucasville, Ohio.

Texas Eastern Transmission Corp. — 40 miles of 30-in. loops in Pennsylvania and 78 miles of 30-in. in Arkansas.

Transcontinental Gas Pipe Line Corp. — 13.4 miles of 36-in. north of Salisbury, N. C. and 22.5 miles of 36-in. north of Appomattox, Va. Superintendent: Earl Saulsman.

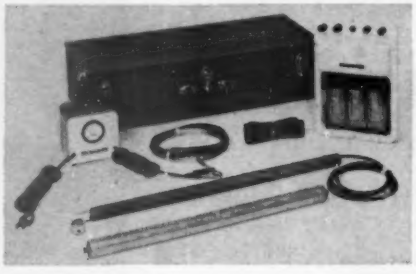
H. B. Zachry Co., Box 10188, San Antonio 21, Tex. *Dixie Pipe Line Co.* — Demopolis, Ala., to Griffin, Ga., a 241-mile, 10 and 12-in. portion of the 1100-mile, 6, 8, 10 and 12-in. LPG line.

New High-Performance

"LITTLE JEEPER"

HOLIDAY DETECTOR

Weighs Only 9 POUNDS Including Battery



Little Jeeper Detector Kit includes: **Battery Charger,** 110 v. 4-amp. with ammeter & circuit breaker • **Ground Cable,** 30 ft., 6-ft. rubber sleeve protects operator • **Battery,** spillproof, rechargeable • **Electrode Connector & Handle** • **Spring Electrode** • **Weatherproof Shipping Case.**

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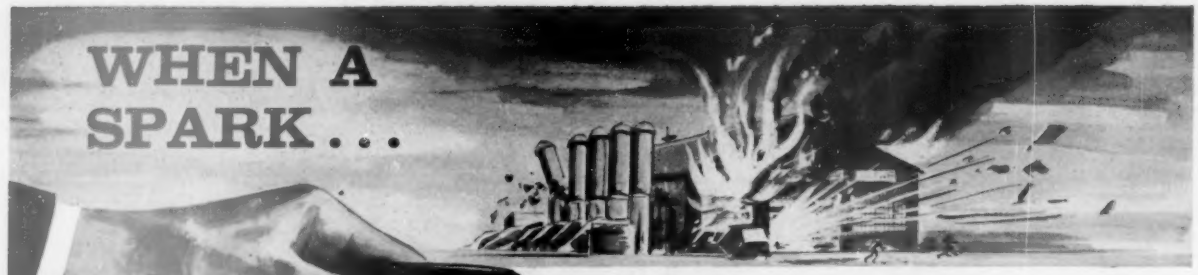

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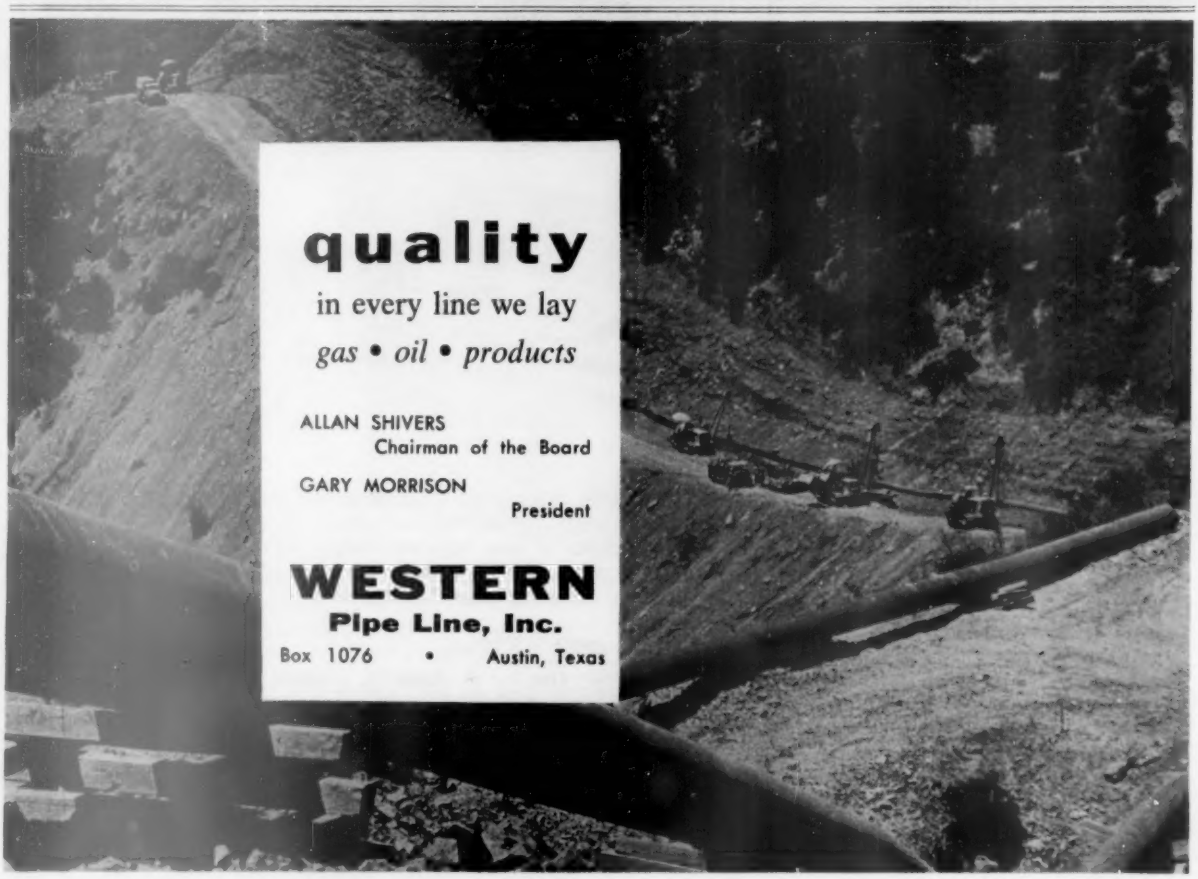

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Pipeline Equipment

Inhibited Descalant

An inhibited scale and oxide remover, Oakite 132, has been introduced. In closed systems, solutions of the compound may be heated to 180 F for faster descaling and derusting. The compound remains stable at high temperatures, has greater tolerance for sulfur dioxide and ferric ions, reduces hazard of copper ions depositing on steel, has a degree of inhibition in the vapor stage of the solution, and has good rinsability with hot or cold water. *Oakite Products Inc.*
Circle number (81) on reply card

Explosion-Proof Switches

Explosion-proof diaphragm pressure switches with set and re-set accuracy of ± ½% can be adjusted externally without exposing the circuit. Without interfering with switch wiring, diaphragm capsules may be interchanged easily to accommodate varying pressure requirements or fluid characteristics. In low setting, the switches will actuate at 0.1-in. mercury with test pressure to 10 psi. In higher ranges, they will go up to 300 psi test pressure at settings to 150 psi. Standard pressure connection is ¼-in. npt female pipe fitting. Single setting and dual control models are available. *Barksdale Valves.*
Circle number (82) on reply card

One-Unit Surveying Tool

As easy to operate as a portable radio is the lightweight, completely transistorized version of the electronic surveying tool, Electrotape. Operating on continuous-wave radar principles, it provides instantaneous measurements of distances measuring from 250 ft to 100 miles. A pair comprises a complete distance-measuring system. Model DM-20 incorporates in one tripod-mounted unit: recessed parabolic antenna; regulated power supply and compact battery; and electronic circuits that perform actual distance measurement. Electrotape automatically measures time lapse between microwave transmission from one unit to the other and back and displays the measurement numeri-

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DETECTRON "505"

This portable precision instrument makes short work of determining exact location and depth of buried pipes, cables, manhole covers. Not a radical experimental design, but proven by years of use in municipalities and industry. Full effectiveness in **all** temperature ranges.

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Fast... Easy Pipe Protection

Joint wrapping of mill coated pipe is easy, fast and *sure* with Arno Pipe-Wrap Tape. Its inert polyethylene backing is moisture proof, non-conductive and resistant to soil acids and alkalis. Tough and stretchy. High-tack adhesive. Write for information and free test sample.

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Model LC 201
TOWER LIGHTING CONTROL UNIT
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Models also available with separate Alarm Signal for each Beacon Lamp.

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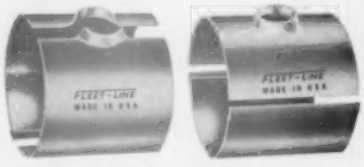
SADDLES, conventional, and for pressure vessel heads. Nozzle sizes from ¼" through 24" with skirts to any size. FLEET-LINE saddles weld neatly into place in much less time and with much less welding rod.



FULL-ENCIRCLEMENT SADDLES, nominal pipe sizes 2" through 36". Five types.

REDUCING TEES, Forged Steel, 8" through 30".

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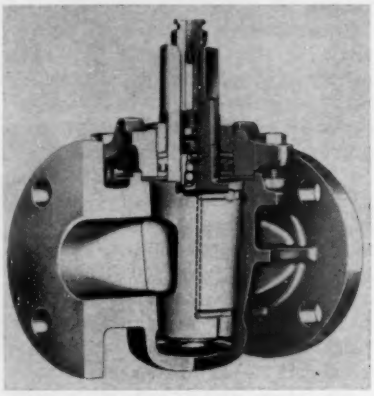
cally in centimeters. Readout can be converted easily into inches, feet, yards, miles or other linear units. A built-in radiotelephone permits operators to converse over long distances. Automatic temperature control permits operation from −40 F to +125 F, night or day, rain or shine. *Cubic Corp.*

Circle number (83) on reply card

Coated Tapered Plug Valves



A tapered plug valve has been introduced that utilizes a high lubricity plastic coating to substantially reduce turning and provide lifetime, maintenance-free operation. Tapered surfaces of Permaturn valves recommended for pressures up to 1000 psi are coated with Teflon. Permaturn valves for services up to 10,000 psi are coated with phosphate-molybdenum disulfide. Permaturn also features: fixed adjustment assembly on low pressure valves to maintain constant, tight seal after repeated openings and closings and to facilitate uniform turning ease; and, on valves for extreme high pressure services, a threadless stem that results in reduction of high operating torques of conventional high pressure valves. *Rockwell Manufacturing Co.*

Circle number (84) on reply card

"Erector Set" Switches

A line of diaphragm pressure switches employs the erector set technique — a standard body to which may be attached interchangeable components such as contact elements, capsules, terminal block housings and explosion-proof housings. This permits wide choice in specifications approximating a custom-made switch. Accuracy is ± 0.5%. Proof pressures to 600 psi and adjustable ranges from vacuum to 400 psi make it possible to use inexpensive diaphragm pressure switches on installations that presently require bourdon tube models. The basic body forms a heavy, protective capsule around the diaphragm, permitting use of an almost unlimited variety of diaphragm metals and thicknesses. *Barksdale Valves.*

Circle number (85) on reply card

Controls Pump As Pig Passes

Pig-Trol automatically indicates and/or starts or stops pumps when a solid pig or plug has passed a given point in a products pipeline. A magnet-attracting sleeve, raised or lowered by the plunger, attracts or releases a permanent magnet attached to a mercury or pneumatic switch. This magnetic principle eliminates need for packings, bellows or stuffing boxes. Two hermetically-sealed switches are provided so that there can be isolated, separate circuits for compressor operation and for telemetering circuits. Because of an extension neck, the control head is at all times mounted above grade. Pig-Trol works equally well on spools, spheres and mechanical or knife-type scrapers. *Magnetrol Inc.*

Circle number (86) on reply card

Aerial Control Inc.

PRECISION SURVEYING

PRECISION ROUTE & LOCATION SURVEYS FOR PIPELINES

Experienced in modern electronic distance measuring, electronic computing and photogrammetric mapping.

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Simple Scraper Trap Closure

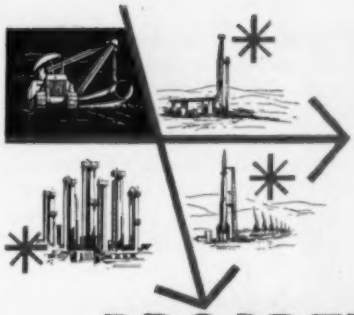
One man can operate a new scraper trap closure featuring unitized assembly. The hinged closure has cap or blanking plug threaded into special fitting butt welded to trap. Supported by fitting hinge, the cap can be swung easily into open or closed position. A polished rod in the center of the cap fits into a bushing at the end of hinge arm permitting the cap to turn freely when being threaded into or out of the special fitting. A special adjustment on the hinge centers cap in fitting to eliminate any drag on threads. This scraper trap closure is available in sizes 8 through 38 in. in ASA 150, 300, 400, 600 and 900 ratings. *Well Equipment Mfg. Corp.*

Circle number (87) on reply card

Loud-Speaking Telephone

"Partial gain-switching" of circuits is incorporated in new Speakerphone—Executive Model to reduce possibility of microphone-speaker feedback. Microphone is automatically muted, but not completely cut off, when speaker circuit is activated. Conversely, speaker volume is reduced when microphone is in use. The sensitive, wide-angle microphone, housed in the base, picks up conversation from anywhere in a normal size room to give caller new freedom of movement. Switching electronically eliminates clipped first syllables of a conversation when switching from party to party. All components are self-contained within the telephone and speaker units, so no special control equipment or power supply is needed. All manual controls are housed within the face plate. *Automatic Electric Co.*

Circle number (88) on reply card



BROADER HORIZONS...

The work of Burden in the North American Pipe Line System Construction field is well known. With the broadening of the world petroleum and gas industry Burden has been actively engaged in work abroad and is now in position to contract for work anywhere.

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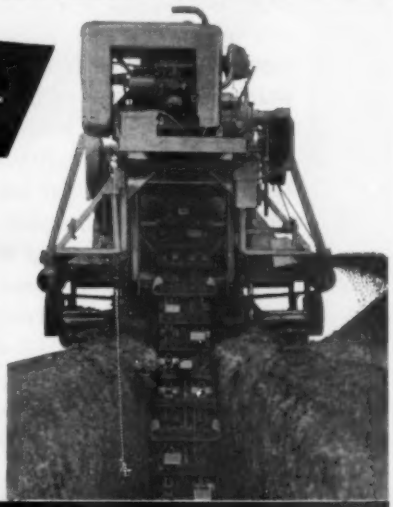
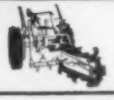
You just can't buy a lower priced BIG ditcher than Vermeer's 524T POW-R-DITCHER. Low original cost . . . low maintenance cost. Digs 8"-24" wide at speeds of 1' to 15' per minute. Ideal for contractors, municipalities, utility companies, pipe-line contractors and institutions.



PICK THE POW-R-DITCHER TO FIT YOUR NEEDS

4T W-3 W-1 3P 

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☐ Also include information on new Vermeer hydraulic back filler.

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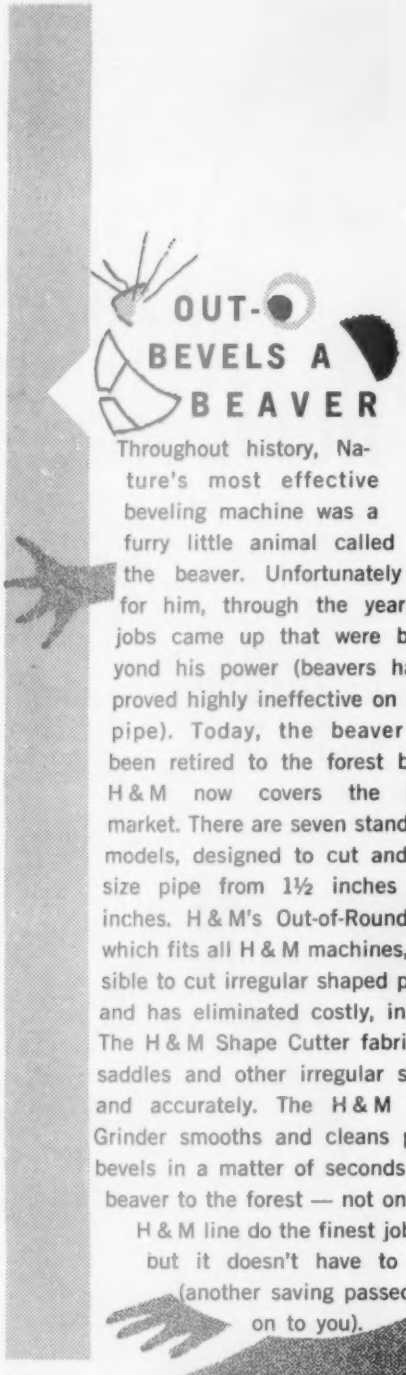

Throughout history, Nature's most effective beveling machine was a furry little animal called the beaver. Unfortunately for him, through the years jobs came up that were beyond his power (beavers have proved highly ineffective on steel pipe). Today, the beaver has been retired to the forest because H & M now covers the beveling market. There are seven standard H & M models, designed to cut and bevel any size pipe from 1½ inches through 36 inches. H & M's Out-of-Round attachment, which fits all H & M machines, makes it possible to cut irregular shaped pipe accurately and has eliminated costly, inaccurate cuts. The H & M Shape Cutter fabricates tees, els, saddles and other irregular shapes quickly and accurately. The H & M "BEVEL-LAND" Grinder smooths and cleans pipe cuts and bevels in a matter of seconds. Retire your beaver to the forest — not only does the H & M line do the finest job possible, but it doesn't have to be fed (another saving passed on to you).

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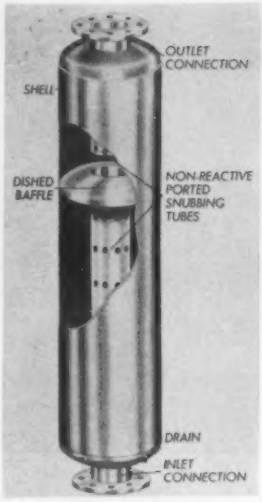
Turbocharged Engine Snubbers

Straight flow principle snubbers have been designed for new turbocharged engines. Pressure drop across exhaust is held to a minimum, which means more usable horsepower. This resuls in top working efficiency of highly refined turbocharged engines. There are no moving parts. This series is available in 8 through 30-in. pipe sizes. Each is designed for a particular level of noise suppression. They will be marketed as BMTA First-Turbo Line, BMTB Turbo-Standard and BMTC Turbo-Pact. *The Burgess-Manning Co.*



Circle number (89) on reply card

Brush Control Breakthrough

A portable hand-gun spray unit with a unique nozzle and a specially-developed non-drift invert herbicide permit, for the first time, invert herbicide application from the ground. The compact, 100-lb Stull unit may be transported and operated from a pickup truck without anchoring. Pumping output may be varied over wide volume and pressure range. Two feed lines, one to a drum of water and another to a special chemical formula, connect to nozzle where components are mixed and water-in-oil emulsion is formed. *Stull Chemical Co.*

Circle number (90) on reply card

Performance Proves "PRIMARY" Orifice Fittings are best . . .

No other primary differential producing devices will match Robertson "PRIMARY" fittings.

Here's Why . . .

The "PRIMARY" seal ring is made of steel covered with 1/16" molded Hycar. A coating of Molybdenum Disulfide is then applied to seal the Hycar and prevent swelling of the seal ring. Teflon and high-temp rings also available.

COMPARE THESE FEATURES:

- Longer Seal Life.
- No Leakage or By-Passing Around Plate.
- Precision Centering of Plate.
- Plate is always square and perpendicular to line bore.
- Simple, Quick Changing of Plates.
- Positive Clamping Device.

These are a few of the reasons why "PRIMARY" Orifice Fittings out-perform all others. Write for Bulletin 1-CNP. Better still, try them, today!

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Antennas For 2-Way Systems

In a new line of base station antennas for 136-174 mc 2-way radio systems are three basic antennas that utilize a center-fed half-wave design with folded radiating element and coaxial skirt section. This eliminates projecting ground plane rods to simplify installation, reduce pattern distortion and minimize ice damage in cold climates. Omnidirectional models (TAD 6070) have increased radiating aperture and low angle of radiation, directing the pattern at the horizon and providing increased area signal coverage for true unity gain. Forward gain in the direction of maximum signal strength for the cardioid series (TAD 6080) is 3 db, and 5.8 db for the unidirectional models (TAD 6090) over standard center fed half-wave dipole antenna. *Motorola Inc.*
Circle number (91) on reply card

Automates Remote Monitoring

An economical system for monitoring "interruptibles" and recording gas flow from multiple remote stations is available. Any flow measurement that can be indicated by contact closure (such as base volume index/positive displacement meters) may be used as input. Gas flow count is transmitted over commercial telephone lines and centrally displayed on individual 5 or 6-digit counters. Recording of counter totals may be on demand or automatic under program control. The programmer scans counters and presents count, with time, to a recording device such as an IBM 523 card punch, paper tape punch or electric typewriter. From 5 to 120 points may be accommodated conveniently. The system is the SD103. *Datex Corp.*
Circle number (92) on reply card

Hinged Clapper Check Valve

Checkaroo is a new and functional rubber seal check valve with clapper hinge pin that pivots clapper out of stream for full pressure and unobstructed passage. It has full pipe opening, resulting in 40% less pressure drop across the valve. The 20-deg clapper hinge pin assures easy action and is said to cut dead weight by 90%. Available in 2, 2½, 3, 4 and 6 in., it is non-lubricated; can be threaded, flanged or victaulic grooved at both ends; and operates in vertical or horizontal position. Double O-ring gaskets eliminate pressure on threads and protect them from outside corrosion. Checkaroo, equipped with pressure gage or test vent, is now available in semi-steel and soon in ductile iron and steel. *Frank Wheatley Pump & Valve Mfr.*
Circle number (93) on reply card

Literature

Pic-A-Pump Catalog

This 1008-page catalog conveniently arranges engineering data for selection of centrifugal, axial or mixed flow pumps best suited to individual and specific applications. A 64-page yellow reference section carries data relating to pumps and hydraulic design, as well as general tables and charts frequently required in the application of moving liquids. *Allis-Chalmers Manufacturing Co.*
Circle number (94) on reply card

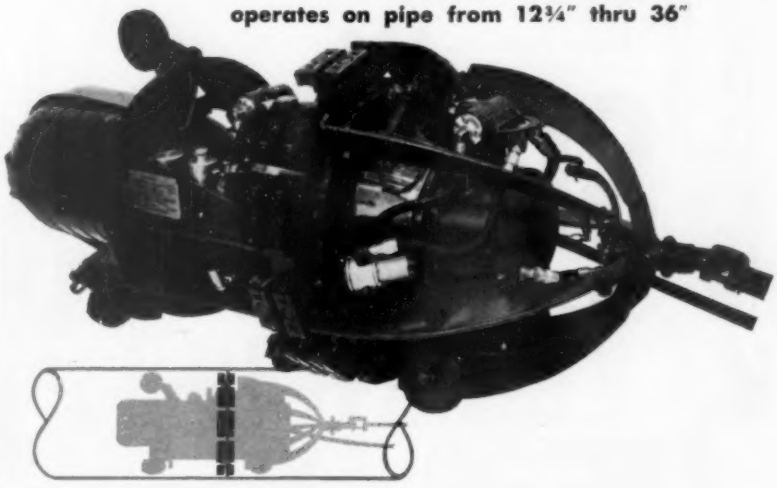
Storage Tank Emergency Vent

Information is available on a new emergency pressure relief vent designed for use with bulk storage tanks to minimize product loss and

COMPLETELY NEW

C-R-C AIR CLAMP*

operates on pipe from 12¾" thru 36"



THE LINE-UP CLAMP
THAT DOES NOT DAMAGE OR SCRATCH PIPE

CHECK THESE FEATURES:

- Rollers roll pipe into perfect round without friction or sliding of clamp.
- Pneumatically controlled heads operate independently for quick, positive line-up.
- COMPLETELY DEPENDABLE. All working parts completely enclosed, and made from aircraft quality steels for the lowest possible maintenance.

* *Patent applied for.*

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insure safer operation. Cutaway photos describe safety features of the No. 209-U which is available in 6 and 10-in. sizes. *OPW-Jordan Corp.*
Circle number (95) on reply card

Meter Catalog

Pipeline meters and the Turbo-Meter are included in a new 28-page catalog. It describes, illustrates and gives specifications and dimensions of Rockwell's complete line of petroleum and industrial meters and accessories. *Rockwell Manufacturing Co.*
Circle number (96) on reply card

Grease Summary

This is a concise, easy-to-read, 32-pager summarizing the basic principles, properties, types and rules for choice and application of lubricating grease. Of interest also is a summary of the effect of additives on grease properties. *Bardahl Manufacturing Corp.*
Circle number (97) on reply card

Electronic Control Stations

Literature introduces new electronic indicating control stations for 24-v and 1-v systems. Described are the 701K's features: full-scale process indication; complete manual power supply; compact design for panel mounting; and pull-out convenience, while still on control. *Taylor Instrument Companies.*
Circle number (98) on reply card

Special Systems Data

A booklet has been issued describing special telemetering and control systems for gas transmission and other applications. *Dynel Inc.*
Circle number (99) on reply card

Gaso-Powered Boring Unit

Illustrated and described in a 6-pager is the new gasoline-powered boring unit that ranges from 200 ft of 12-in. diam hole to 150 ft of 36-in. hole on the horizontal or at angles up to 30 deg from the horizontal. A capacity chart is presented. *Kwik-Mix Co., Div. of Koehring Co.*
Circle number (100) on reply card

Info For Machine Users

"Profit Tips" is a detailed fold-out brochure describing new tips, teeth and shanks on Caterpillar rippers, as well as dozer, scraper and loader cutting edge improvements. The new weld-on adapter for No. 9 and No. 8 rippers, allowing use of new tips with all types of shanks, is featured. *Caterpillar Tractor Co.*
Circle number (101) on reply card

Electric Flow Meters

A revised 2-page specification sheet covers four basic models of electric instruments with pneumatic control. They control liquid flow or liquid level and record and/or indicate it. Two models also record fluid temperature and pressure, respectively. *Minneapolis-Honeywell Regulator Co.*
Circle number (102) on reply card

All-Products Bulletin

"Compression and Power" lists a complete line of engine and motor driven compressors, power engines, expansion engines, industrial jet-powered gas turbines and En-Tronic control systems and their many applications. The company also lists its on-the-spot field, warehouse and engineering services. *The Cooper-Bessemer Corp.*
Circle number (103) on reply card

Two-Way Radio Publication

Tubed and transistorized VHF two-way radios, in powers of from 10 to 100 w, are featured in a new 24-pager. *General Electric Communication Products Dept.*
Circle number (104) on reply card

the
SPREAD
is the thing . . .

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Pipeline People

W. A. Robinson

Wallace A. Robinson has joined Mid-Valley Pipeline Co. as chief engineer after 12 years' service with Sun Pipeline Co. as field, mechanical and senior engineer. He assisted in the original design and construction of Mid-Valley's facilities while on loan assignment from Sun, has also served as a pipeline construction consultant for the U. S. Army Dept. and assisted in design and installation of Venezuelan-Sun terminal facilities.

Nelson E. Trumbull has been named president of Marathon Pipe Line Co. and elected to the board of directors. He formerly was senior planning associate in the forward planning division of Marathon's parent, The Ohio Oil Co. He succeeds Jack H. Rice who has been appointed Ohio Oil vice president of supply and transportation. New vice president and director of Marathon is Max L. Stanfield, formerly manager of the Rocky Mountain region.

Cities Service Pipe Line Co. has promoted Paul B. Ridlon to division superintendent. Ridlon, whose area of operation will include Kansas, Texas and Southern Louisiana, formerly was district superintendent at Wilson, Okla. Dean F. Smalley will continue as division superintendent in Oklahoma, and Harry O. McLeod as division superintendent of the Arkansas Pipe Line system.

Robert O. Koch has been named vice president and general counsel of Texas Gas Transmission Corp. He formerly was home office counsel for Tidewater Oil Co. and also has served as Texas' assistant attorney general.

R. O. Koch

W. M. Elmer

Texas Gas Transmission Co.'s president, W. M. Elmer, has been elected president of the Independent Natural Gas Association of America. Other officers for the coming year are: Orville S. Carpenter, first vice president; and George P. Garver, second vice president. New directors are Mills Cox, W. K. Sanders and W. J. Bowen.

John LeRoy Smith has been named to the post of tax commissioner for Service Pipe Line Co. A former Tulsa county assessor, he succeeds J. S. Stearns, retired.

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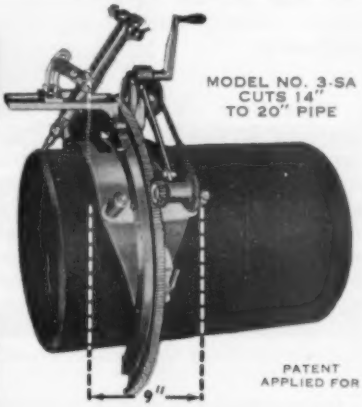

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Pipeline Parade

R. E. Simpson

Mineral Fiber Mfg. Corp. has been formed in Houston, Tex., to produce glass fiber pipeline felt. President is Robert E. Simpson, formerly regional manager for L-O-F Glass Fibers Co. One of the vice presidents is J. P. Bristow, president of Bristow-Hyde Construction Co.

Mid-Valley Pipeline Co. has awarded a contract to North Electric Co. to install automation controls on all 14 pump stations on its 930-mile system between Longview, Texas, and Lima, Ohio. North Electric will provide Paricode supervisory control and telemetering equipment.

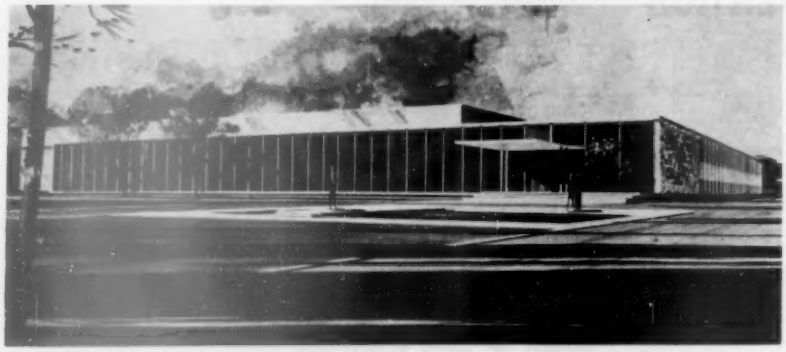
Clark Bros. Co. and Roots-Connersville Blower, divisions of Dresser Industries Inc., have announced new offices and a move of their Los Angeles offices. Clark Bros. has opened a branch of its Pittsburgh office in Buffalo, N. Y., with Charles P. Clark Jr. in charge. Roots-Connersville Blower has opened a new branch office in Midland, Texas, and appointed LeRoy C. Laycock branch manager. The Los Angeles offices of both firms have been moved to 5915 E. Sheila Street.

A. O. Smith Corp. has changed the name of its reinforced plastics division to the glass fiber products division. The division offers Red Thread glass fiber pipe which for more than five years has been field tested for such uses as crude oil gathering, gas gathering and distillate lines.

Gulf States Asphalt Co. Inc., through association with Trumbull Asphalt Co. of Delaware, has increased to 17 the number of plants where its pipe enamel is produced.

Collins Radio Co. has integrated all microwave activities into one organization within its new systems division, the Alpha Corp., formerly a subsidiary. This realignment unites microwave sales, systems engineering, contract administration, training and customer service under a new director, Kerry R. Fox.

All lift trucks now coming off the production line at Allis-Chalmers Manufacturing Co.'s Harvey, Ill., works are painted yellow because of its international identification with safety. Orange previously used will still be available, however, to those preferring it.



A $1,500,000 research center is being planned by The Kendall Co., Chicago division, manufacturer of Polyken industrial tapes and protective coatings. The new facility will be located in Barrington, Ill. Completion is expected to be in the fall of 1962.

Appointments and Promotions

Air Reduction Sales Co.—G. L. Werly Jr., general marketing manager, formerly gas marketing department manager.

Allis-Chalmers Mfg. Co.—Will Mitchell Jr., research division director, formerly the division's acting director.

Bucyrus-Erie Co.—Donald W. Waack, sales promotion manager, formerly assistant sales development manager for Schield Bantam Company.

Clark Bros. Co., Div. of Dresser Industries Inc. – has appointed the following as sales engineers for engines, compressors and gas turbines: M. S. "Mel" Kenady, Amarillo office; Z. B. "Zobo" Deer, Tulsa office; Edward S. Leonard, Houston office; and Thomas R. Bett, Shreveport office.

Dresser Manufacturing Div., Dresser Industries Inc. — Charles I. Gilmer, Rocky Mountain sales representative, formerly sales representative for Western State Machine Co.

Fibercast Co., Continental-Emsco — Philip J. Liston, sales manager, formerly assistant sales manager in charge of special projects.

Grove Valve and Regulator Co.— sales engineers, George H. Loeffler and M. L. Wheat, both to be headquartered in Houston.

Jones & Laughlin Steel Corp. — J. B. Gibson, district sales manager in Houston, formerly assistant manager of tubular products sales in Pittsburgh.

Pipeline Products Inc. — Robert J. Becker, sales staff, formerly associated with the E. W. Robinson Supply Co.

Raytheon Co. — James D. Bowen, sales manager for the Sorenson product lines, formerly eastern sales manager for Sola Electric Co. and sales engineer for Sorenson & Co. Inc. before that firm was acquired by Raytheon in 1959.

Worthington Corp.'s Standard Pump Div. — Patrick L. McManus, general manager, formerly director of marketing services.

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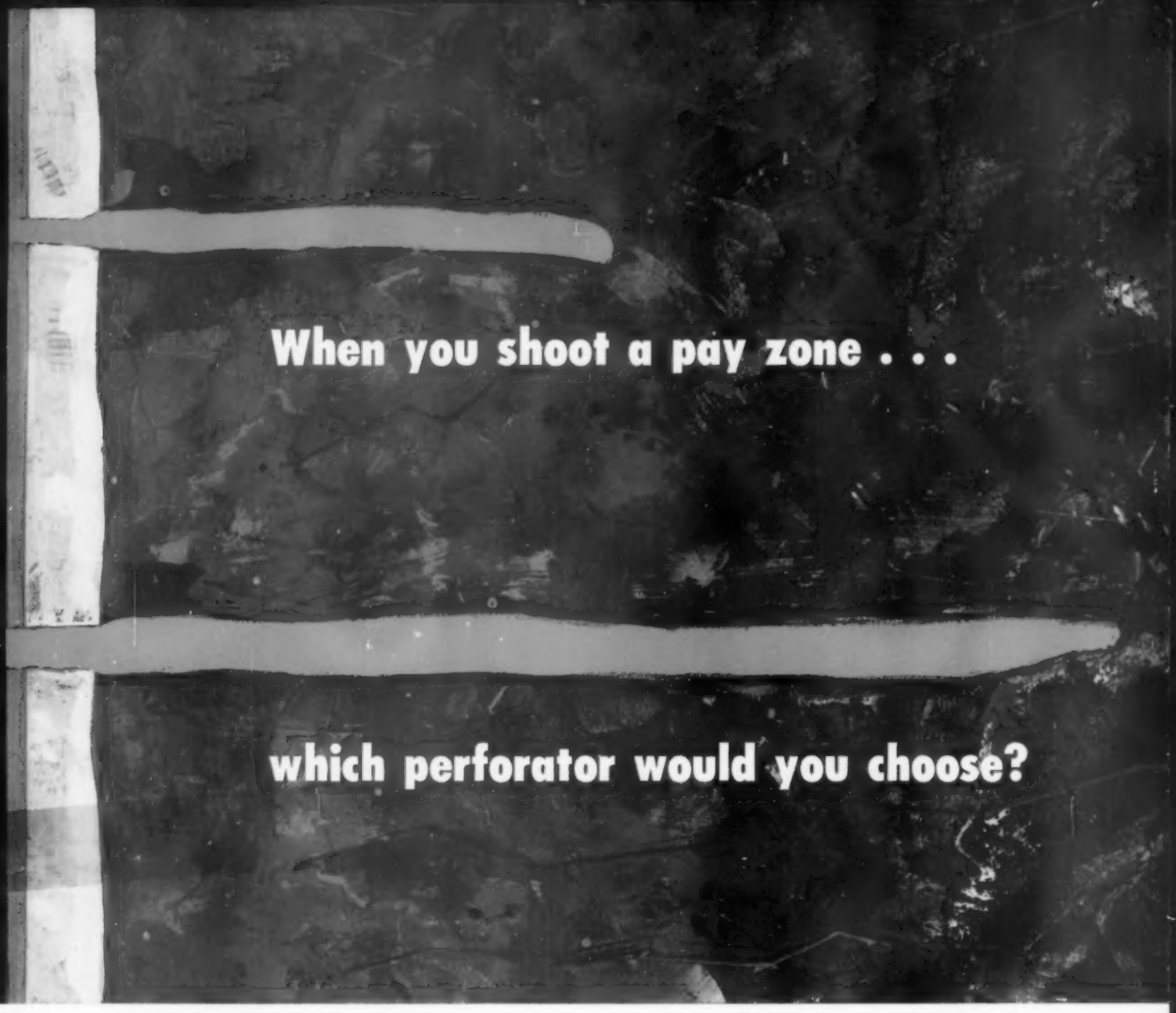

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Hole size (casing)	.3*	.5*
Probe depth	9⅝"*	11⅛"*
Total depth	9¾"*	11¾"*
Burr height	.064*	.155*
Well Flow Index	1.5	2.0

**The Koneshot NCF II Perforator has been tested in accordance with the Perforation Investigation Committee standard test procedure which provides standard targets and procedures for comparing performance of all guns tested. The Perforation Investigation Committee makes no endorsement of the perforating equipment tested and makes no interpretation of the standard test data obtained.*

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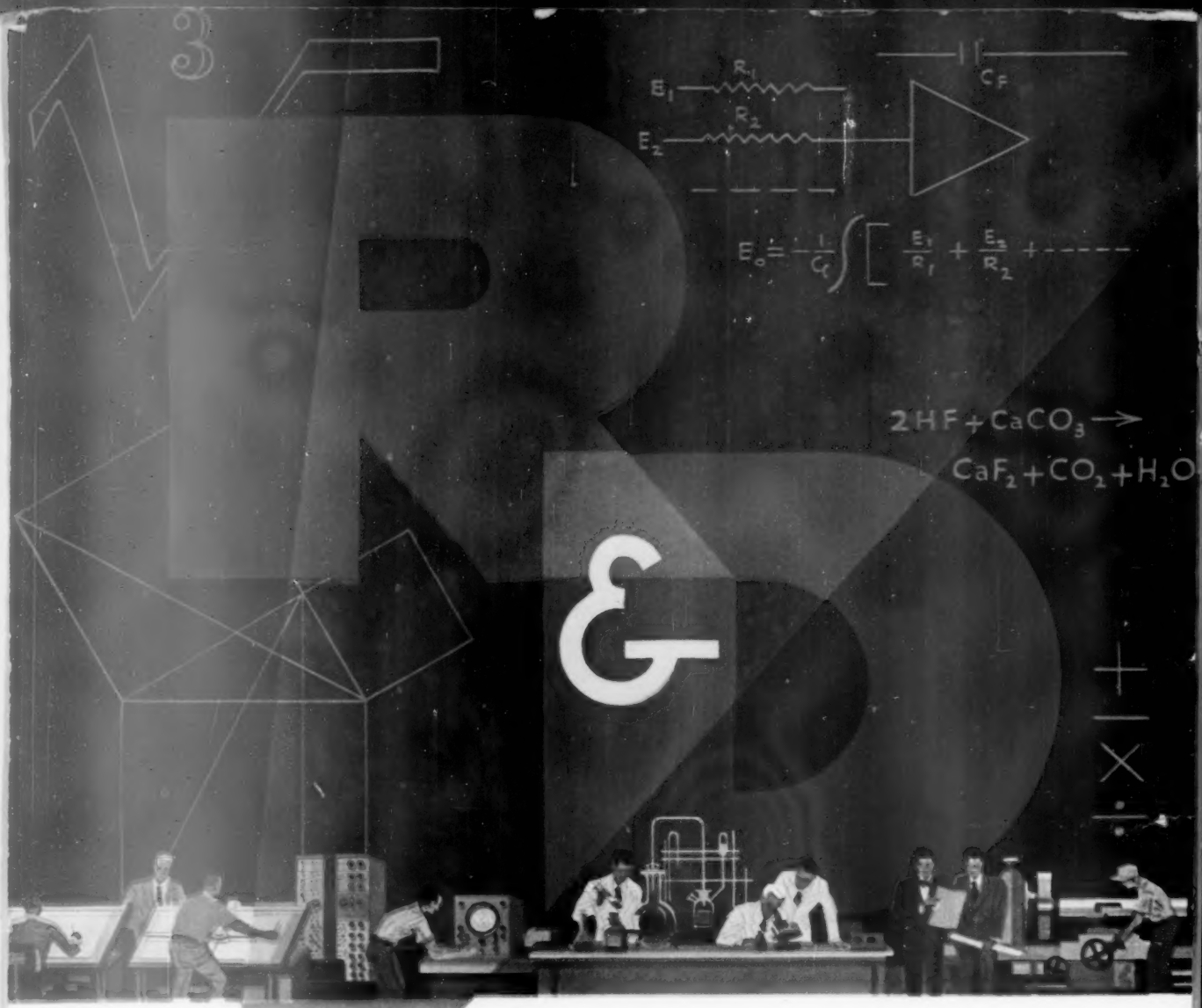

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